

SINAMICS S150

Converter Cabinet Units 75 kW to 1200 kW

Operating Instructions · 10/2008

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SINAMICS S150 Drive converter cabinet units

Operating Instructions

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Warning notice system

This manual contains notices you have to observe in order to ensure your personal safety, as well as to prevent damage to property. The notices referring to your personal safety are highlighted in the manual by a safety alert symbol, notices referring only to property damage have no safety alert symbol. These notices shown below are graded according to the degree of danger.

 DANGER
indicates that death or severe personal injury will result if proper precautions are not taken.
 WARNING
indicates that death or severe personal injury may result if proper precautions are not taken.
 CAUTION
with a safety alert symbol, indicates that minor personal injury can result if proper precautions are not taken.
CAUTION
without a safety alert symbol, indicates that property damage can result if proper precautions are not taken.
NOTICE
indicates that an unintended result or situation can occur if the corresponding information is not taken into account.


If more than one degree of danger is present, the warning notice representing the highest degree of danger will be used. A notice warning of injury to persons with a safety alert symbol may also include a warning relating to property damage.

Qualified Personnel

The device/system may only be set up and used in conjunction with this documentation. Commissioning and operation of a device/system may only be performed by **qualified personnel**. Within the context of the safety notes in this documentation qualified persons are defined as persons who are authorized to commission, ground and label devices, systems and circuits in accordance with established safety practices and standards.

Proper use of Siemens products

Note the following:

 WARNING
Siemens products may only be used for the applications described in the catalog and in the relevant technical documentation. If products and components from other manufacturers are used, these must be recommended or approved by Siemens. Proper transport, storage, installation, assembly, commissioning, operation and maintenance are required to ensure that the products operate safely and without any problems. The permissible ambient conditions must be adhered to. The information in the relevant documentation must be observed.

Trademarks


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Disclaimer of Liability

We have reviewed the contents of this publication to ensure consistency with the hardware and software described. Since variance cannot be precluded entirely, we cannot guarantee full consistency. However, the information in this publication is reviewed regularly and any necessary corrections are included in subsequent editions.

Preface

User documentation

 WARNING
Before installing and commissioning the converter, make sure that you read all the safety notes and warnings carefully, including the warning labels on the equipment itself. The warning labels must always be legible. Missing or damaged labels must be replaced.

Structure of this documentation

The customer documentation comprises general and individual documentation.

The general documentation describes the topics that apply to all cabinet units:

- **Operating Instructions**
The Operating Instructions consist of the following sections:
 - Device description
 - Mechanical installation
 - Electrical installation
 - Commissioning guide
 - Description of function
 - Maintenance instructions
 - Technical specifications
- **Overview diagrams**
These provide a general overview of the functionality of the cabinet units.
- **Basic function diagrams**
These provide an overview of the basic functions of the cabinet unit for simple applications.
- **List Manual**
The List Manual consists of the following sections:
 - Parameter list
 - Function diagrams
 - Fault / warning list
- **Documentation for Drive Control Chart (DCC)**
 - Programming and Operating Manual: DCC Editor description
 - Function Manual: Description of the standard DCC blocks

The individual documentation describes precisely one customized cabinet unit and contains the following:

- **Dimension drawing**
The dimension drawing documents the dimensions of the ordered cabinet unit.
- **Layout diagram**
The layout diagram shows the components installed in the ordered cabinet unit.
- **Circuit diagram**
The circuit diagram shows the electrical components installed in the ordered cabinet unit, their interconnections and the customer interfaces.
- **Terminal diagram**
The terminal diagram shows all the customer terminals in the ordered cabinet unit, and the associated internal wiring in the cabinet unit. This diagram documents the line-side target wiring.
- **Spare parts list**
The spare parts list contains all the available spare parts for the ordered cabinet unit.
- **Additional operating instructions**
The instructions for OEM components installed in the ordered cabinet unit are supplied as OEM documentation.

Technical support

- Tel: +49 (0) 180 50 50 222
- Fax: +49 (0) 180 50 50 223
- Internet: <http://www.siemens.de/automation/support-request>

Note

Calls are subject to charge (e.g. € 0.14/min from fixed lines within Germany). Tariffs of other phone providers may differ.

Spare parts

You will find spare parts on the Internet at:
<http://support.automation.siemens.com/WW/view/en/16612315>.

Internet address

Information about SINAMICS can be found on the Internet at the following address:
<http://www.siemens.com/sinamics>

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Safety information

1.1 Warnings



WARNING

Hazardous voltages are present when electrical equipment is in operation. Severe personal injury or substantial material damage may result if these warnings are not observed.

Only qualified personnel are permitted to work on or around the equipment. This personnel must be thoroughly familiar with all warning and maintenance procedures described in these operating instructions.

The successful and safe operation of this device is dependent on correct transport, proper storage and installation, as well as careful operation and maintenance. National safety guidelines must be observed.



DANGER

Five safety rules

When carrying out any kind of work on electrical devices, the "five safety rules" must always be observed:

1. Disconnect the system.
2. Protect against reconnection.
3. Make sure that the equipment is de-energized.
4. Ground and short-circuit.
5. Cover or enclose adjacent components that are still live.

Certification

The following certificates:

- EC declaration of conformity
- Certificate of compliance with order
- EC manufacturer's declaration

can be found under "Safety and Operating Instructions" in the documentation folder.

1.2 Safety and operating instructions



 DANGER

<p>This equipment is used in industrial high-voltage installations. During operation, this equipment contains rotating and live, bare parts. For this reason, they could cause severe injury or significant material damage if the required covers are removed, if they are used or operated incorrectly, or have not been properly maintained.</p>

<p>When the machines are used in non-industrial areas, the installation location must be protected against unauthorized access (protective fencing, appropriate signs).</p>

Prerequisites

Those responsible for protecting the plant must ensure the following:

- The basic planning work for the plant and the transport, assembly, installation, commissioning, maintenance, and repair work is carried out by qualified personnel and/or checked by experts responsible.
- The operating manual and machine documentation are always available.
- The technical specifications regarding the applicable installation, connection, environmental, and operating conditions are always observed.
- The plant-specific assembly and safety guidelines are observed and personal protection equipment is used.
- Unqualified personnel are forbidden from using these machines and working near them.


This operating manual is intended for qualified personnel and only contain information and notes relating to the intended purpose of the machines.

The operating manual and machine documentation are written in different languages as specified in the delivery contracts.

Note

We recommend engaging the support and services of your local Siemens service center for all planning, installation, commissioning and maintenance work.

1.3 Components that can be destroyed by electrostatic discharge (ESD)

 CAUTION
<p>The board contains components that can be destroyed by electrostatic discharge. These components can be easily destroyed if not handled properly. If you do have to use electronic boards, however, please observe the following:</p> <ul style="list-style-type: none"> • You should only touch electronic boards if absolutely necessary. • When you touch boards, however, your body must be electrically discharged beforehand. • Boards must not come into contact with highly insulating materials (such as plastic parts, insulated desktops, articles of clothing manufactured from man-made fibers). • Boards must only be placed on conductive surfaces. • Boards and components should only be stored and transported in conductive packaging (such as metalized plastic boxes or metal containers). • If the packaging material is not conductive, the boards must be wrapped with a conductive packaging material (such as conductive foam rubber or household aluminum foil).

The necessary ESD protective measures are clearly illustrated in the following diagram:

- a = conductive floor surface
- b = ESD table
- c = ESD shoes
- d = ESD overall
- e = ESD wristband
- f = cabinet ground connection
- g = contact with conductive flooring

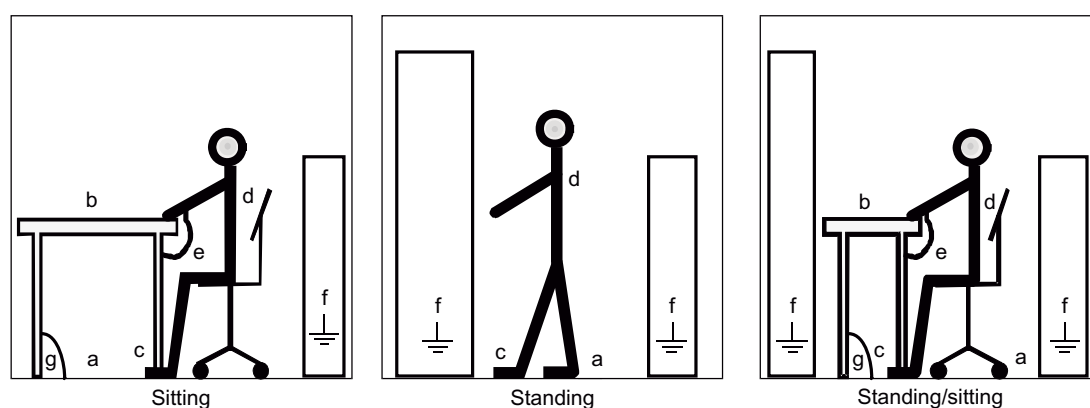


Figure 1-1 ESD protective measures

Residual risks of power drive systems

When carrying out a risk assessment of the machine/plant in accordance with the EU Machinery Directive, the machine manufacturer/plant operator must consider the following residual risks associated with the control and drive components of a power drive system (PDS).

1. Unintentional movements of driven machine components during commissioning, operation, maintenance, and repairs caused by, for example:
 - Hardware defects and/or software errors in the sensors, controllers, actuators, and connection technology
 - Response times of the controller and drive
 - Operating and/or ambient conditions not within the scope of the specification
 - Parameterization, programming, cabling, and installation errors
 - Use of radio devices / cellular phones in the immediate vicinity of the controller
 - External influences / damage
2. Exceptional temperatures as well as emissions of light, noise, particles, or gas caused by, for example:
 - Component malfunctions
 - Software errors
 - Operating and/or ambient conditions not within the scope of the specification
 - External influences / damage
3. Hazardous shock voltages caused by, for example:
 - Component malfunctions
 - Influence of electrostatic charging
 - Induction of voltages in moving motors
 - Operating and/or ambient conditions not within the scope of the specification
 - Condensation / conductive contamination
 - External influences / damage
4. Electrical, magnetic and electromagnetic fields generated in operation that can pose a risk to people with a pacemaker, implants or metal replacement joints, etc. if they are too close.
5. Release of environmental pollutants or emissions as a result of improper operation of the system and/or failure to dispose of components safely and correctly.

For more information about residual risks of the Power Drive System components, see the relevant chapters in the technical user documentation.

 **WARNING****Electromagnetic fields "electro smog"**

Electromagnetic fields are generated by the operation of electrical power engineering installations such as transformers, converters or motors.

Electromagnetic fields can interfere with electronic devices, which could cause them to malfunction. For example, the operation of heart pacemakers can be impaired, potentially leading to damage to a person's health or even death. It is therefore forbidden for persons with heart pacemakers to enter these areas.

The plant operator is responsible for taking appropriate measures (labels and hazard warnings) to adequately protect operating personnel and others against any possible risk.

- Observe the relevant nationally applicable health and safety regulations. In Germany, "electromagnetic fields" are subject to regulations BGV B11 and BGR B11 stipulated by the German statutory industrial accident insurance institution.
- Display adequate hazard warning notices.



- Place barriers around hazardous areas.
- Take measures, e.g. using shields, to reduce electromagnetic fields at their source.
- Make sure that personnel are wearing the appropriate protective gear.

1.3 Components that can be destroyed by electrostatic discharge (ESD)

Device overview

2.1 Chapter content

This chapter provides information on the following:

- Introduction to the cabinet units
- The main components and features of the cabinet unit
- The cabinet unit wiring
- Explanation of the type plate

2.2 Applications, features, and design

2.2.1 Applications

SINAMICS S150 drive converter cabinet units are used for variable-speed drives with exacting demands regarding performance, and include drives with:

- High dynamic requirements
- Frequent braking cycles and high braking energy
- Four-quadrant operation

Typical applications for SINAMICS S150 include:

- Test bay drives
- Centrifuges
- Elevators and cranes
- Paper and rolling mill drives
- Cross cutters and shears
- Conveyor belts
- Presses
- Cable winches

2.2.2 Features, quality, service

Features

The self-commutating, pulsed feed/feedback unit, which is based on IGBT technology and is equipped with a clean-power filter, makes the minimum of demands on the line:

- The innovative clean-power filter minimizes line-side harmonics
- Power feedback (four-quadrant operation)
- Tolerant vis-à-vis fluctuations in the supply voltage
- Operation on weak lines
- Reactive power compensation is possible (inductive or capacitive)
- High drive dynamics

In addition, factors have been considered to ensure easy handling of the drive from the planning and design phase through to operation. These factors include:

- Compact, modular, service-friendly design
- Straightforward planning and design thanks to the Sizer and Starter tools
- Ready to connect to facilitate the installation process
- Quick, menu-driven commissioning with no complex parameterization
- Clear and convenient operation via a user-friendly graphical operator panel with measured values displayed in plain text or in a quasi-analog bar display.
- SINAMICS is an integral part of Totally Integrated Automation (TIA). The TIA concept offers an optimized range of products for automation and drive technology. This concept is characterized by planning / design, communication, and data management procedures that are consistent throughout the product range. SINAMICS is fully integrated in the TIA concept.
Separate S7/PCS7 blocks and faceplates for WinCC are available.
- Integration in SIMATIC H systems is possible via a Y link.
- Drive Control Chart (DCC)
Drive Control Chart (DCC) expands the facility for the simplest possible configuring of technological functions for the SINAMICS drive system.
The block library encompasses a large selection of closed-loop, arithmetic and logic function blocks, as well as more comprehensive open-loop and closed-loop control functions. The user-friendly DCC editor enables easy graphical configuration and a clear representation of control loop structures as well as a high degree of reusability of existing diagrams. DCC is an add-on to the STARTER commissioning tool.

Quality

The SINAMICS S150 drive converter cabinet units are manufactured to meet high standards of quality and exacting demands.

This results in a high level of reliability, availability, and functionality for our products.

The development, design, and manufacturing processes, as well as order processing and the logistics supply center have been certified to DIN ISO 9001 by an independent authority.

Service

Our worldwide sales and service network offers our customers consulting services tailored to their needs, provides support with planning and design, and offers a range of training courses.

For detailed contact information and the current link to our Internet pages, refer to chapter "Diagnosis / faults and alarms", section "Service and Support".

2.3 Structure

The SINAMICS S150 drive converter cabinet units are characterized by their compact, modular, and service-friendly design.

Line and motor-side components as well as additional monitoring devices can be installed in the converter cabinet units.

A wide range of electrical and mechanical components enable the drive system to be optimized in line with prevailing requirements.

The cabinet unit comprises up to two cabinet panels with a total width of between 1400 mm and 2800 mm, depending on the output.

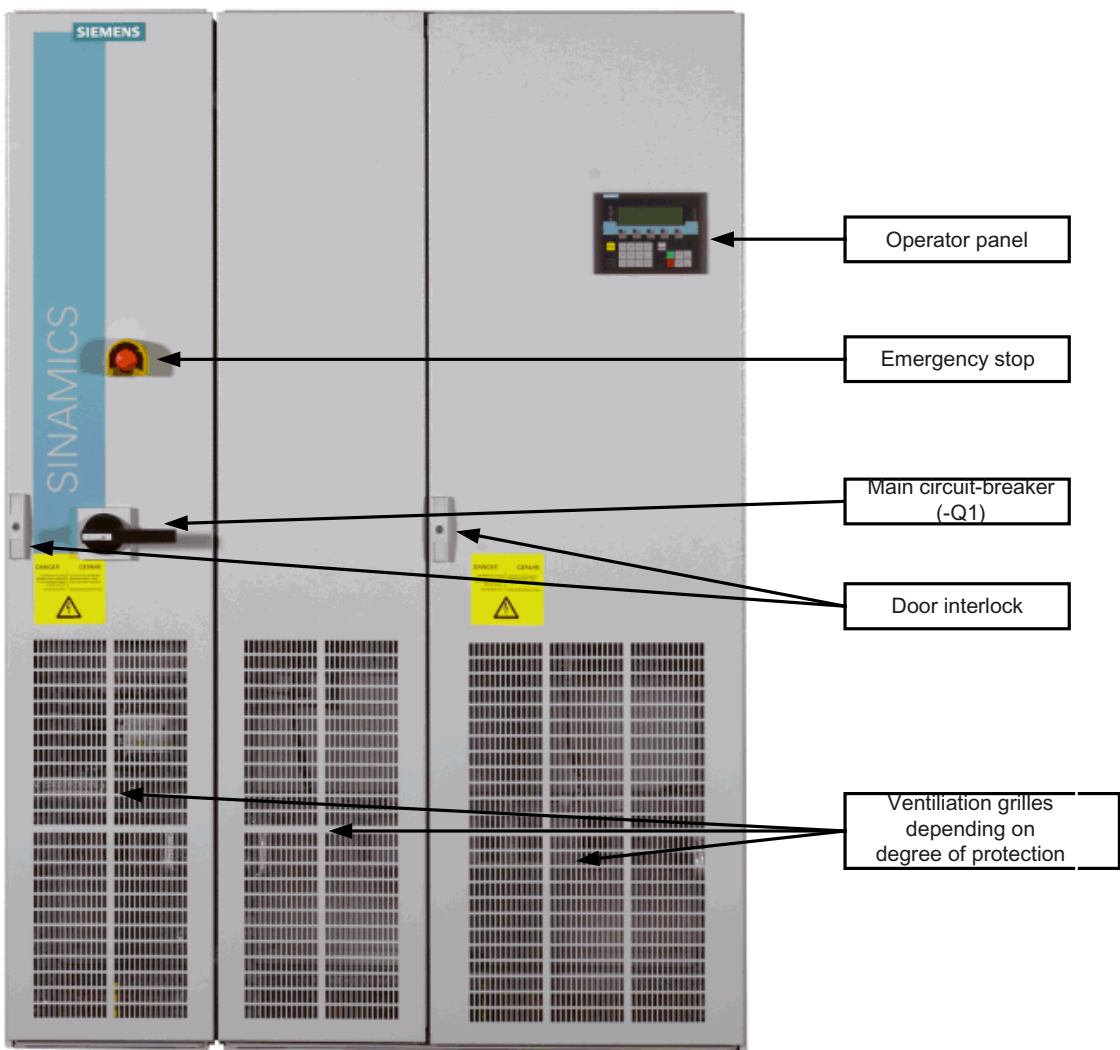


Figure 2-1 Example of a cabinet unit (e.g. 132 kW, 400 V 3 AC) (certain components optional)

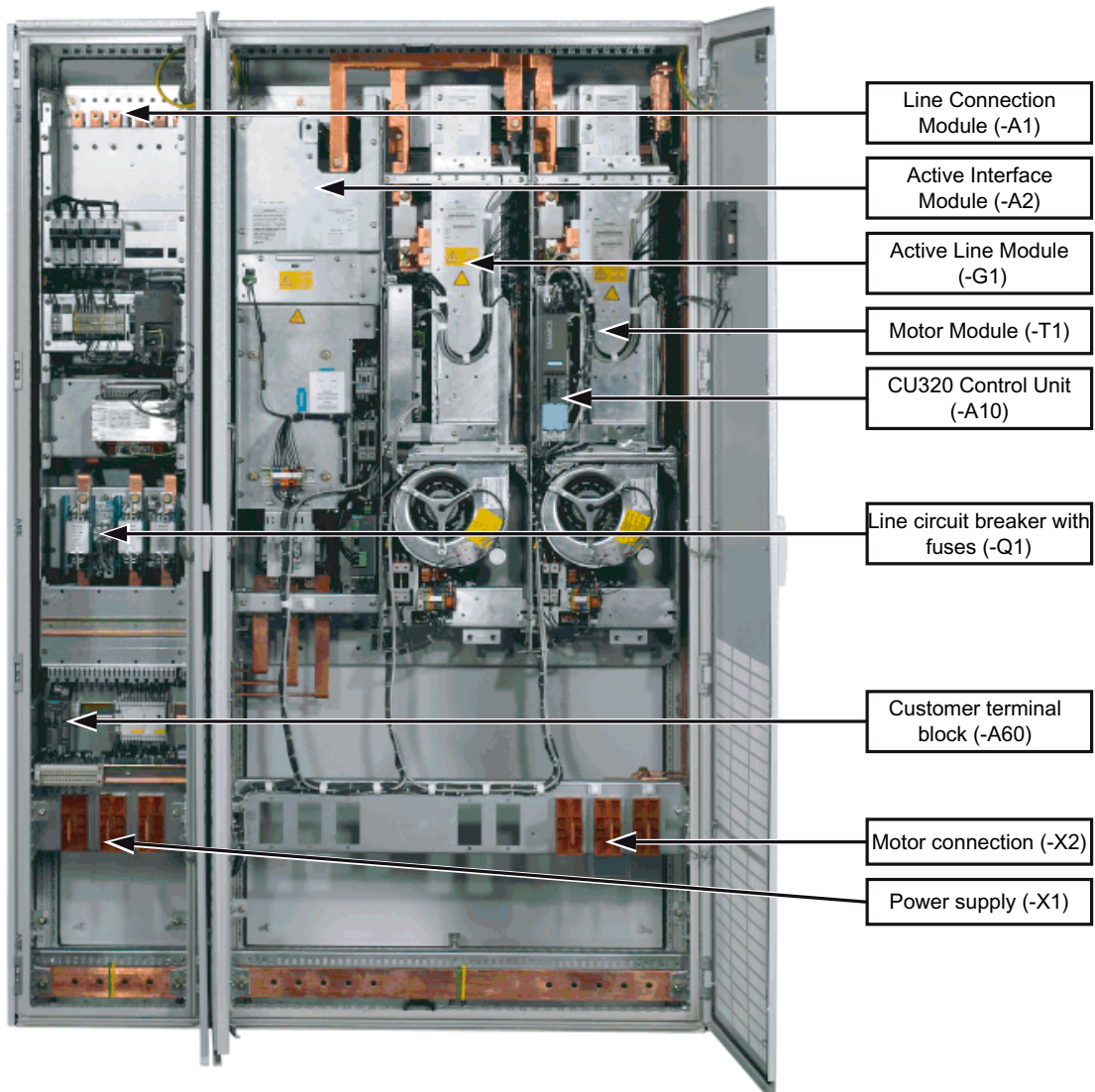
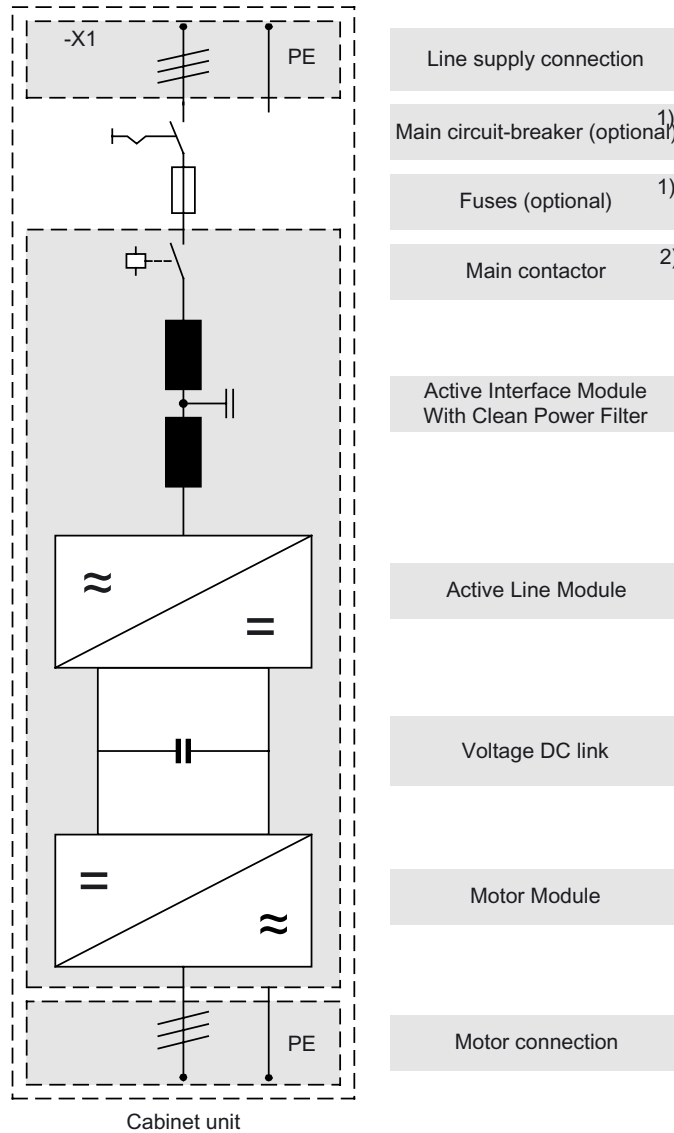


Figure 2-2 Example of a cabinet unit (e.g. 132 kW, 400 V 3 AC) (certain components optional)

2.4 Wiring principle

Wiring principle: version A



- 1) Main circuit-breaker with fuses for output current < 800 A only
 2) Main contactor for output current < 800 A / circuit-breaker for output current > 800 A available as standard.

Figure 2-3 Wiring principle of the cabinet unit

NOTICE
 The PE connection at the motor must be fed back directly to the cabinet unit.

2.5 Type plate

Specifications on the type plate


SIEMENS


SINAMICS S150 AC DRIVE / FREQUENZUMRICHTER ← Device designation

input:	3AC	380 – 480 V	197 A	
Eingang:				
Output:	3AC	0 – 480 V	210 A	Duty Class: I
Ausgang:				Bel. – Klasse:
Temperature Range:		0 – 40 C		Cooling method: AF
Temperaturbereich:				Kühlart:
Degree of protection:		IP20		Weight: 708 kg
Schutzart:				Gewicht:

Order number: 1P **6SL3710-7LE32-1AA0-Z** ← List of device options
 Bestellnummer: L26 + L45 + L50 + L59 + L83 + L84 + L86

CE

Serial Number: 
 Fabrik – Nummer: S **N-S52249230014345**

Version: A  ← Month of manufacture
 Version: *A* ← Year of manufacture

Made in EU (Germany)

Figure 2-4 Type plate for the cabinet unit

Date of manufacture

The date of manufacture can be determined as follows:

Table 2- 1 Production year and month

Letter/number	Year of manufacture	Letter/number	Month of manufacture
S	2004	1 to 9	January to September
T	2005	O	October
U	2006	N	November
V	2007	D	December
W	2008		
X	2009		

Type plate specifications (from type plate above)

Table 2- 2 Specifications on the type plate

Specification	Value	Explanation
Input	3 AC 380 – 480 V 239 A	Three-phase connection Rated input voltage Rated input current
Output	3 AC 0 – 480 V 210 A	Three-phase connection Rated output voltage Rated output current
Temperature range	0 – 40 °C	Ambient temperature range within which the cabinet unit can operate under 100 % load
Degree of protection	IP20	Degree of protection
Duty class	I	I: Duty class I to EN 60146-1-1 = 100 % (continuously) (with the specified current values, the cabinet unit can operate continuously under 100 % load)
Cooling method	AF	A: Cooling medium: air F: circulation method: forced cooling, drive unit (fan) in the device
Weight		Weight of the cabinet unit

Explanation of the option short codes

Table 2- 3 Explanation of the option short codes

Input options	
L00	Line filter for use in the first environment to EN 61800-3, category C2 (TN/TT systems)
L26	Main circuit breaker incl. fuses for output currents < 800 A
Output options	
L08	Motor reactor
L10	dv/dt filter plus Voltage Peak Limiter
L15	Sine-wave filter (only for 380 V – 480 V 3 AC, max. 250 kW)
Input and output options	
M70	EMC shield bus
Motor protection and safety functions	
L45	EMERGENCY OFF pushbutton installed in the cabinet door
L57	EMERGENCY OFF category 0, 230 V AC or 24 V DC
L59	EMERGENCY STOP category 1, 230 V AC
L60	EMERGENCY STOP category 1, 24 V AC
L83	Thermistor motor protection unit with PTB approval
L84	Thermistor motor protection unit with PTB approval
L86	PT100 evaluation unit
L87	Insulation monitoring
M60	Additional shock protection
Increase in degree of protection	
M21	Degree of protection IP21
M23	Degree of protection IP23
M43	Degree of protection IP43
M54	Degree of protection IP54
Mechanical options	
M06	Base 100 mm high, RAL 7022
M07	Cable compartment 200 mm high, RAL 7035
M13	Line connection from above
M78	Motor connection from above
M90	Crane transport assembly (top-mounted)
Other options	
G20	CBC10 Communication Board
G33	CBE20 Communication Board
G61	Customer terminal block extension TM31
K46	Sensor Module Cabinet-Mounted SMC10
K48	Sensor Module Cabinet-Mounted SMC20
K50	Sensor Module Cabinet-Mounted SMC30
K51	VSM10 Voltage Sensing Module Cabinet-Mounted
K82	Terminal module for controlling the "Safe Torque Off" and "Safe Stop 1" safety functions
L19	Connection for external auxiliary equipment

2.5 Type plate

L50	Cabinet illumination with service socket
L55	Cabinet anti-condensation heating
L61	25 kW / 125 kW braking unit (380 V - 480 V, 660 V - 690 V)
L62	50 kW / 250 kW braking unit (380 V - 480 V, 660 V - 690 V)
L64	25 kW / 125 kW braking unit (500 V - 600 V)
L65	50 kW / 250 kW braking unit (500 V - 600 V)
Y09	Special paint finish for cabinet
Documentation (standard: English / German)	
D02	Customer documentation (circuit diagram, terminal diagram, layout diagram) in DXF format
D04	Customer documentation as hard copy
D14	Draft of customer documentation
D58	Documentation language: English / French
D60	Documentation language: English / Spanish
D80	Documentation language: English / Italian
Languages (standard: English / German)	
T58	Rating plate data in English / French
T60	Rating plate data in English / Spanish
T80	Rating plate data in English / Italian
Industry-specific options (chemicals)	
B00	NAMUR terminal block
B02	Separate 24 V power supply (PELV)
B03	Outgoing section for external auxiliary equipment (uncontrolled)
Options specific to the shipbuilding industry	
M66	Marine version
E11	Individual certificate from Germanischer Lloyd (GL)
E21	Individual certificate from Lloyds Register (LR)
E31	Individual certificate from Bureau Veritas (BV)
E51	Individual certificate from Det Norske Veritas (DNV)
E61	Individual certificate from American Bureau of Shipping (ABS)
Converter acceptance inspection in presence of customer	
F03	Visual acceptance
F71	Function test of the converter without motor connected
F75	Function test of the converter with test bay motor (no load)
F77	Insulation test on converter
F97	Customer-specific converter acceptance inspections (on request)

Mechanical installation

3.1 Chapter content

This chapter provides information on the following:

- The conditions for transporting, storing, and installing the cabinet unit
- Preparing and installing the cabinet unit

3.2 Transportation and storage

Transportation

 **WARNING**

The following must be taken into account when the devices are transported:

- The devices are heavy. Their center of gravity is displaced and they can be top heavy.
- Suitable hoisting gear operated by trained personnel is essential due to the weight of the devices.
- The devices must only be transported in the upright position indicated. The devices must not be transported upside down or horizontally.
- Serious injury or even death and substantial material damage can occur if the devices are not lifted or transported properly.

Note

Information about shipping

- The devices are packaged by the manufacturer in accordance with the climatic conditions and stress encountered during transit and in the recipient country.
- The notes on the packaging for transportation, storage, and proper handling must be observed.
- For transportation using forklifts, the devices must be set down on a wooden pallet.
- When the devices are unpacked, they can be transported using the optional transport eyebolts (option M90) or rails on the cabinet unit. The load must be distributed evenly. Heavy blows or impacts must be avoided during transit and when the devices are being set down, for example.
- Permissible ambient temperatures:
Ventilation: -25°C to +70°C, class 2K3 to IEC 60 721-3-2
Down to -40°C for max. 24 hours

Note

Notes regarding built-in line-side components

If built-in system-side components are to be installed on doors or side panels, you must take the following points into account:

- The degree of protection (IP20, IP21, IP23, IP43, IP54) must not be reduced as a result.
 - The electromagnetic compatibility of the cabinet unit must not be adversely affected.
 - When control elements are installed on side or rear panels, these panels must be grounded separately.
-

Note

Notes regarding damage in transit

- Carry out a thorough visual inspection of the device before accepting the delivery from the shipping company.
- Check that you have received all the items specified on the delivery note.
- Notify the shipping company immediately of any missing components or damage.
- If you identify any hidden defects or damage, contact the shipping company immediately and ask them to examine the device.
- If you fail to contact them immediately, you may lose your right to claim compensation for the defects and damage.
- If necessary, you can request the support of your local Siemens office.

 WARNING
--

Damage in transit indicates that the device has been subject to unreasonable stress. The electrical safety of the device can no longer be ensured. It must not be connected until a thorough high-voltage test has been carried out.

Non-observance can result in death, severe personal injury or substantial property damage.

Storage

The devices must be stored in clean, dry rooms. Temperatures between -25°C and $+70^{\circ}\text{C}$ are permissible. Temperature variations greater than 20 K per hour are not permitted.

If the device is stored for a prolonged period once it has been unpacked, cover it or take other appropriate measures to ensure that it does not become dirty and that it is protected against environmental influences. Failure to take such measures will invalidate any claims for damages under the terms of the warranty.

 WARNING
--

The device should not be stored for more than two years. If the device is stored for more than two years, its DC link capacitors must be reformed during commissioning.

The reforming procedure is described in "Maintenance and servicing".

3.3 Installation

 **WARNING**

To ensure that the devices operate safely and reliably, they must be properly installed and commissioned by qualified personnel, taking into account the warnings provided in these operating instructions.

In particular, the general and national installation and safety guidelines for high-voltage installations (e.g. VDE – the Union of German Technical Engineers) as well as the guidelines relating to the proper use of tools and personal protective equipment must be observed.

Death, serious injury, or substantial material damage can result if these factors are not taken into account.

3.3.1 Mechanical installation: checklist

Use the following checklist to guide you through the mechanical installation procedure for the cabinet unit. Read the safety information at the start of these Operating Instructions before you start working on the device.

Note

Check the boxes accordingly in the right-hand column if the activity applies to the cabinet unit in your scope of supply. In the same way, check the boxes once you have finished the installation procedure to confirm that the activities are complete.

Item	Activity	Fulfilled/Complete	
1	The ambient conditions must be permissible. See "Technical specifications, General technical specifications". The cabinet unit must be firmly attached to the fixing points provided. The cooling air can flow unobstructed.	<input type="checkbox"/>	<input type="checkbox"/>
2	The minimum ceiling height (for unhindered air outlet) specified in the Operating Instructions must be observed. The cooling air supply must not be obstructed (see "Mechanical installation/preparation").	<input type="checkbox"/>	<input type="checkbox"/>
3	Components that are supplied separately for transport reasons (canopy or hood) must be fitted (see "Mechanical installation/Fitting additional canopies (option M21) or hoods (option M23/M43/M54)").	<input type="checkbox"/>	<input type="checkbox"/>
4	The clearance around an open door (escape route) specified in the applicable accident prevention guidelines must be observed.	<input type="checkbox"/>	<input type="checkbox"/>
5	With option M13/M78: Choose the required metric screw connections or conduit thread connections on the basis of the cable cross-section and drill the required holes in the blanking plates. When the cable is fed in from above, ensure that enough room is available if the cable has to be bent because of the cable feeder and cross-sections. The cable entries should be fed in vertically to minimize transverse forces on the entries (see "Mechanical installation / line connection from above (option M13), motor connection from above (option M78)").	<input type="checkbox"/>	<input type="checkbox"/>

3.3.2 Preparation

On-site requirements

The cabinet units are designed for installation in closed, electrical operating areas in compliance with EN 61800-5-1. A closed electrical operating area is a room or area containing electrical equipment which can be accessed by trained personnel only. Access is controlled by a door or other form of barricade which can be opened only by means of a key or other tool. The room or area is also clearly signed with appropriate warning notices.

The operating areas must be dry and free of dust. The air supplied must not contain any electrically conductive gas, vapors, or dust, which could impair operation. It may be necessary to filter the air supplied to the installation room. If the air contains dust, filter mats (option M54) can be installed in front of the ventilation grilles in the cabinet doors and also in front of the hoods, if necessary. Option M54 offers additional protection against water sprayed against the housing from any direction and corresponds to degree of protection IP54.

The permissible values for climatic ambient conditions must be taken into account.

At temperatures > 40°C (104°F) and altitudes > 2000 m, the devices must be derated.

The basic version of the cabinet units complies with the IP20 degree of protection in accordance with EN 60529.

The built-in units are installed in accordance with the dimension drawings supplied. The clearance between the top of the cabinet unit and the ceiling is also specified on the dimension drawings.

The cooling air for the power unit is drawn in from the front through the ventilation grilles in the lower part of the cabinet doors. The warmed air is expelled through the perforated top cover or the ventilation grilles in the top cover (with option M13/M23/M43/M54/M78). Cooling air can also be supplied from below through raised floors or air ducts, for example. To allow this, you have to create openings in the 3-section bottom plate.

According to EN 61800-3, the cabinet units are not suitable for use in low-voltage public networks that supply residential buildings. High-frequency interference may occur if it is used in this type of network.

Additional measures (e.g. line filter, option L00) can be fitted for use in the first environment to EN 61800-3 category C2.

Unpacking the cabinets

Check the delivery against the delivery note to ensure that all the items have been delivered. Check that the cabinet is intact.

The packaging material must be discarded in accordance with the applicable country-specific guidelines and rules.

Required tools

To install the connections, you will require:

- Spanner or socket spanner (w/f 10)
- Spanner or socket spanner (w/f 13)
- Spanner or socket spanner (w/f 16/17)
- Spanner or socket spanner (w/f 18/19)
- Hexagon-socket spanner (size 8)
- Torque wrench up to 50 Nm
- Screwdriver, size 2
- Screwdriver Torx T20
- Screwdriver Torx T30

3.3.3 Installation

Lifting the cabinet off the transport pallet

The applicable local guidelines regarding the transportation of the cabinet from the transport palette to the installation location must be observed.

A crane transport assembly (option M90) can also be fitted on the top of the cabinet.

The fixing screws on the transport pallet can be removed from the pallet base without having to raise the cabinet unit. The positions of the fixing screws are indicated by red markings on the outside of the pallets.

Installation

Four holes for M12 screws are provided on each cabinet panel to secure the cabinet to the ground. The fixing dimensions are specified on the dimension drawings enclosed.

3.3.4 Fitting additional canopies (option M21) or hoods (option M23, M43, M54)

To increase the degree of protection of the cabinets from IP20 (standard) to IP21, IP23, IP43, or IP54, additional canopies or hoods are supplied. These must be fitted once the cabinets have been installed.

Description

The degree of protection can be increased to IP21 by fitting an additional canopy. The canopy is flush-mounted with the cabinet unit and is fitted using spacers at a distance of 250 mm above the top of the cabinet. As a result, cabinets with a canopy are 250 mm higher.

Cabinet units with degree of protection IP23 are supplied with additional hoods, as well as plastic ventilation grilles and braided plastic in the air inlet (doors) and outlet (hoods). The hoods are flush with the cabinets at the side and front and have a recess at the rear so that air can escape even if the cabinet is wall mounted. Air escapes from the front and back. The hood is secured by means of the four holes for the crane hooks in the cabinet. Fitting hoods increases the height of the cabinet by 400 mm.

Cabinet units with degree of protection IP43 are supplied with additional hoods, as well as plastic ventilation grilles and close-meshed braided plastic in the air inlet (doors) and outlet (hoods). The hoods are flush with the cabinets at the side and front and have a recess at the rear so that air can escape even if the cabinet is wall mounted. Air escapes from the front and back. The hood is secured by means of the four holes for the crane hooks in the cabinet. Fitting hoods increases the height of the cabinets by 400 mm.

Compliance with degree of protection IP43 requires an intact filter medium, which must be serviced on a regular basis according to the prevailing ambient conditions.

Cabinet units with degree of protection IP54 are supplied with additional hoods, plastic ventilation grilles, and a filter medium in the air inlet (doors) and outlet (hoods). The hoods are flush with the cabinets at the side and front and have a recess at the rear so that air can escape even if the cabinet is wall mounted. Air escapes from the front and back. The hood is secured by means of the four holes for the crane hooks in the cabinet. Hoods increase the height of the cabinet by 400 mm.

Compliance with degree of protection IP54 requires an intact filter medium, which must be replaced on a regular basis according to the prevailing ambient conditions. Filters can be fitted and replaced from outside the cabinet relatively easily.

Attaching a canopy to increase the degree of protection to IP21 (option M21)

1. Remove the crane transport assembly (if fitted).
2. Attach the spacers to the roof of the cabinet at the positions specified. You may have to remove the protective grille.
3. Fit the canopy to the spacers.

NOTICE

In order to prevent water dripping into the spaces between the cabinet units connected in series, there are "drain channels" on the sides of the canopies. When fitting the canopies, make sure that the "drain channels" interlock.

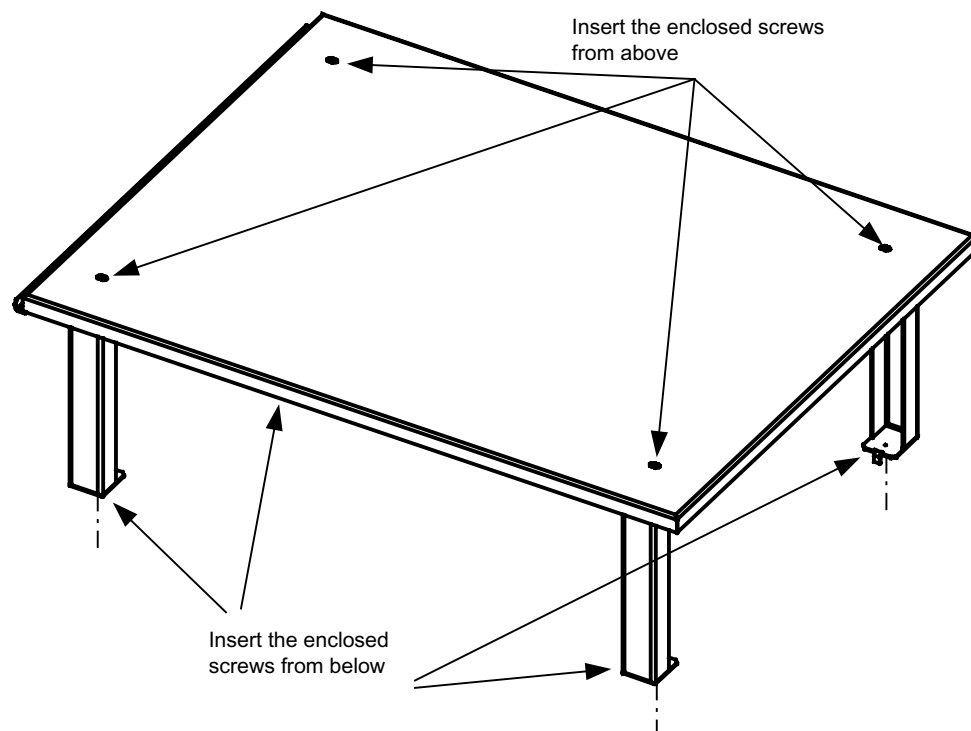


Figure 3-1 Fitting a canopy

Fitting a hood to increase the degree of protection to IP23/IP43/IP54 (option M23/M43/M54)

1. Remove the crane transport assembly (if fitted).
2. Make sure that a perforated top cover is not fitted on the top of the cabinet (depending on production requirements, this can be fitted at a later stage).
3. Options M43 and M54 only:
Use the sealing tape provided to attach the contact surfaces of the hood to the top of the cabinet.
4. Fit the hood to the roof of the cabinet at the positions specified (fixing points for the crane transport assembly).

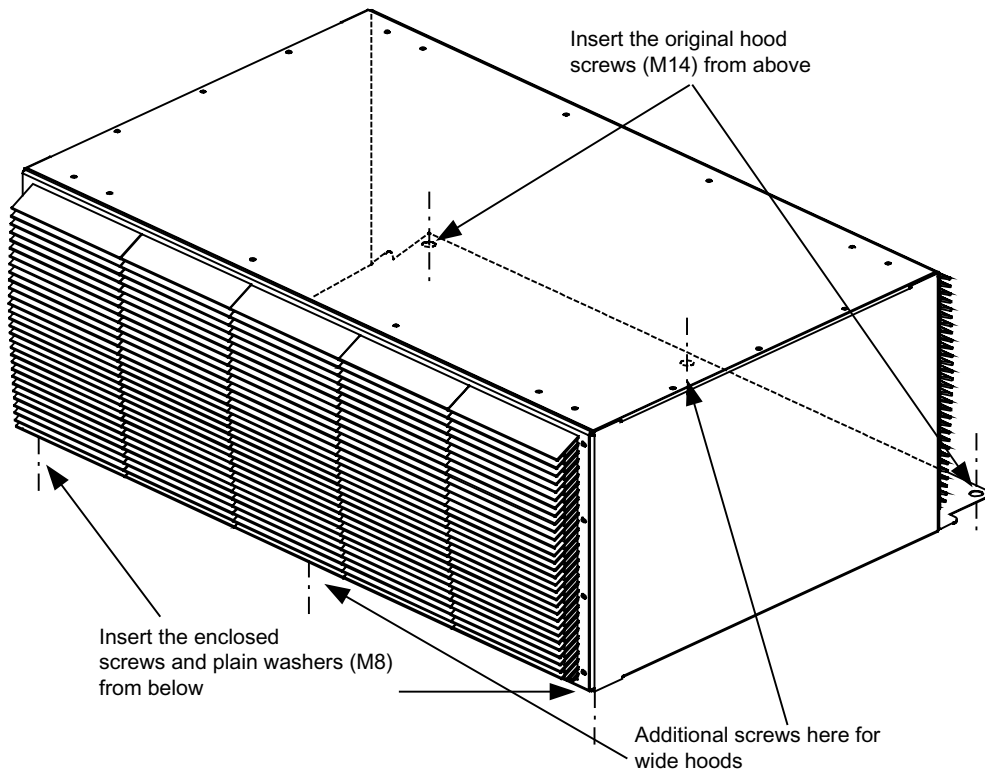


Figure 3-2 Attaching a hood

3.3.5 Line connection from above (option M13), motor connection from above (option M78)

Description

With options M13 and M78, the cabinet unit is equipped with an additional hood. The connection straps for the power cables, the clamping bar for mechanically securing the cables, an EMC shield bus, and a PE busbar are located within the hood.

The hood adds an extra 405 mm to the cabinet height. The busbars for connection from above are fully mounted when the system is delivered. For transport reasons, the hoods are delivered separately and must be mounted on site. With options M23, M43 and M54, plastic ventilation grilles and filter mats are also supplied.

A 5 mm aluminum mounting plate (with no holes) is fitted in the roof of the cover for feeding in the cables. Depending on the number of cables and the cross-sections used, holes for attaching cable glands for feeding in the cables must be drilled in this mounting plate on site.

Note

The control cables and optional brake resistors are connected as before from below.

Attaching the Hood

1. Remove the crane transport assembly (if fitted).
2. Options M43 and M54 only:
Use the sealing tape provided to attach the contact surfaces of the hood to the top of the cabinet.
3. Fit the hood to the roof of the cabinet at the positions specified (fixing points for the crane transport assembly).
4. To secure the power cables, remove the front panel of the hood.

3.3 Installation

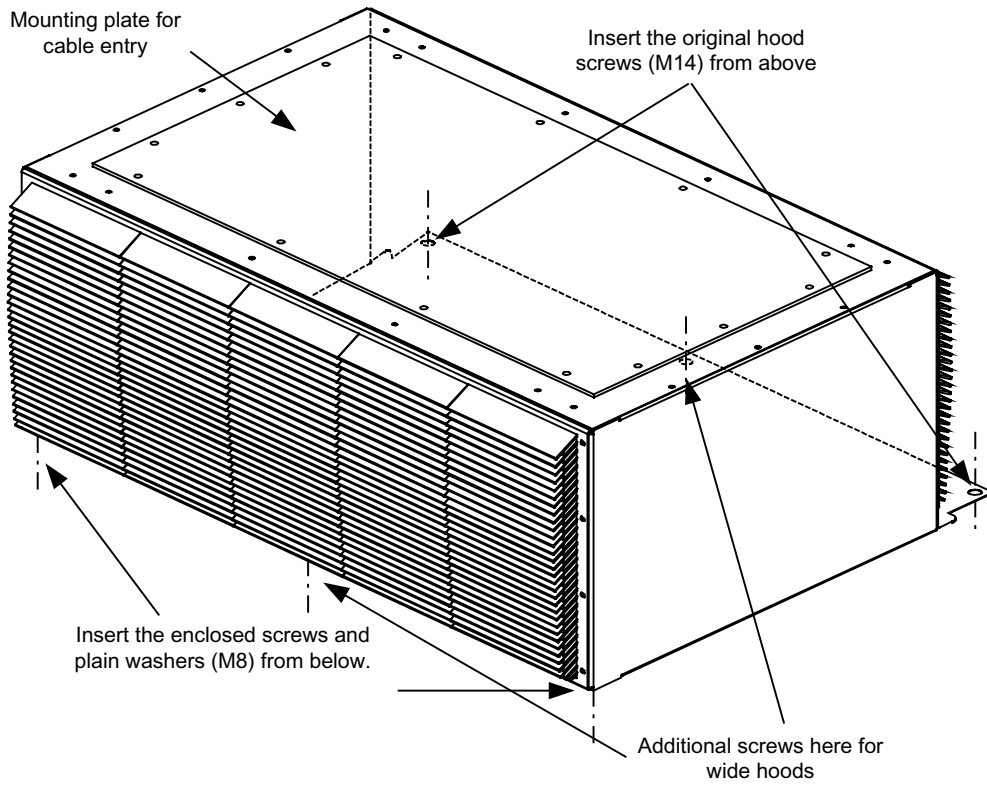


Figure 3-3 Attaching the hood with M13 / M78

Electrical installation

4.1 Chapter content

This chapter provides information on the following:

- Establishing the electrical connections for the cabinet unit
- Adjusting the fan voltage and the internal power supply to local conditions (supply voltage)
- The customer terminal block and its interfaces
- The interfaces for additional options

4.2 Checklist for electrical installation

Use the following checklist to guide you through the electrical installation procedure for the cabinet unit. Read the safety information at the start of these Operating Instructions before you start working on the device.

Note

Check the boxes accordingly in the right-hand column if the activity applies to the cabinet unit in your scope of supply. In the same way, check the boxes once you have finished the installation procedure to confirm that the activities are complete.

Item	Activity	Fulfilled/Complete	
Power connections			
1	The line-side and motor-side power cables must be dimensioned and routed in accordance with the ambient and routing conditions. The maximum permissible cable lengths between the converter and motor must be observed depending on the type of cable used (see "Electrical installation / Power connections / Connection cross-sections and cable lengths"). The PE ground at the motor must be fed back directly to the cabinet unit. The cables must be properly connected with a torque of 50 Nm to the cabinet unit terminals. The cables for the motor and low-voltage switchgear must also be connected with the required torques.	<input type="checkbox"/>	<input type="checkbox"/>
2	The cables between the low-voltage switchgear and the cabinet unit must be protected with line fuses to provide adequate conductor protection (VDE 636, Part 10). See "Technical specifications" for the appropriate fuses.	<input type="checkbox"/>	<input type="checkbox"/>
3	For strain relief, the cables must be clamped on the cable propping bar (C-type mounting bar).	<input type="checkbox"/>	<input type="checkbox"/>
4	When EMC-shielded cables are used, screwed glands that connect the shield to ground with the greatest possible surface area must be provided on the motor terminal box. On the cabinet, the cables must be grounded with the clips supplied with the EMC shield bus with the greatest possible surface area (shield bus supplied with option L00 or can be ordered separately with option M70 – see "Electrical installation / EMC-compliant installation").	<input type="checkbox"/>	<input type="checkbox"/>
5	The cable shields must be properly applied and the cabinet properly grounded at the appropriate points (see "Electrical installation / EMC-compliant installation").	<input type="checkbox"/>	<input type="checkbox"/>
6	The voltage of the fan transformers in the Active Line Module (-G1 -T10) and in the Motor Module (-T1 -T10) and in the internal power supply (-A1-T10) must be set. Larger cabinet units have 2 fan transformers each in the Active Line Module and in the Motor Module (-G1-T10/-T20) and (-A1-T10/-T20), which must be set jointly (see section "Electrical installation / Power connections / Adjusting the fan voltage (-G1-T10, -T1-T10)" and "Electrical installation / Power connections / Adjusting the internal power supply (-A1 -T10)").	<input type="checkbox"/>	<input type="checkbox"/>
7	Before the cabinet is operated from an ungrounded supply/IT system, the connection bracket for the interference suppression capacitor on the Active Interface Module (-A2) must be removed (see "Electrical installation / Removing the connection bracket for the interference suppression capacitor with operation from an ungrounded supply").	<input type="checkbox"/>	<input type="checkbox"/>

Item	Activity	Fulfilled/Complete
8	The type plate can be used to ascertain the date of manufacture. If the period from the date of manufacture to initial commissioning or the cabinet unit downtime is less than two years, the DC link capacitors do not have to be re-formed. If the downtime period is longer than two years, they must be reformed in accordance with the description found in the section "Maintenance and servicing / Reforming the DC link capacitors".	<input type="checkbox"/> <input type="checkbox"/>
9	With an external auxiliary supply, the cable for the 230 V AC supply must be connected to terminal -X40 (see "Electrical installation / Power connections / External supply of the auxiliary supply from a secure line").	<input type="checkbox"/> <input type="checkbox"/>
10	Option L10 dv/dt filter plus Voltage Peak Limiter During commissioning, the filter must be selected via STARTER or AOP30. You are advised to check the selection by ensuring that p0230 is set to 2. The required parameters are set automatically (see "Electrical installation / Other connections / dv/dt filter plus Voltage Peak Limiter (option L10)").	<input type="checkbox"/> <input type="checkbox"/>
11	Option L15 Sine-wave filter During commissioning, the filter must be selected via STARTER or AOP30. You are advised to check the selection by ensuring that p0230 is set to 3. The required parameters are set automatically (see "Electrical installation / Other connections / Sine-wave filter (option L15)").	<input type="checkbox"/> <input type="checkbox"/>
12	Option L19 Connection for external auxiliary equipment To supply auxiliary equipment (e.g. separately-driven fan for motor), the drive must be properly connected to terminals -X155:1 (L1) to -X155:3 (L3). The supply voltage of the auxiliary equipment must match the input voltage of the cabinet unit. The load current must not exceed 10 A and must be set at -Q155 in accordance with the load connected (see "Electrical installation / Other connections / Connection for external auxiliary equipment (option L19)").	<input type="checkbox"/> <input type="checkbox"/> Set value: _____
13	Option L26 Main circuit breaker (incl. fuses/circuit breakers) In equipment with main circuit breaker, the release current must be set to match the installation requirements (see "Electrical Installation / Other connections / Main switch incl. fuses or main circuit breaker (option L26)").	<input type="checkbox"/> <input type="checkbox"/>
14	Option L50 Cabinet illumination with service socket The 230 V auxiliary supply for the cabinet illumination with an integrated service socket must be connected to terminal -X390 and protected with a fuse (max. 10 A) on the line side (see "Electrical installation / Other connections / Cabinet illumination with service socket (option L50)").	<input type="checkbox"/> <input type="checkbox"/>
15	Option L55 Cabinet anti- condensation heating The 230 V auxiliary supply for the anti-condensation heating for the cabinet (230 V / 50 Hz, 100 W / or 230 V / 50 Hz 2 x 100 W for cabinets with a width of 800 to 1200 mm) must be connected to terminals -X240: 1 to 3 and protected with fuses (max. 16 A) (see "Electrical installation / Other connections / Anti-condensation heating for cabinet (option L55)").	<input type="checkbox"/> <input type="checkbox"/>

4.2 Checklist for electrical installation

Item	Activity	Fulfilled/Complete
Signal connections		
16	<p>Cabinet unit operation by higher-level controller / control room. The control cables must be connected in accordance with the interface assignment and the shield applied. Taking into account electrical interference and the distance from power cables, the digital and analog signals must be routed with separate cables.</p> <p>When the analog inputs on the customer terminal block are used as current or voltage inputs, selectors S5.0 and S5.1 must be set accordingly (see "Electrical installation / Signal connections / Customer terminal block (-A60)").</p>	<input type="checkbox"/> <input type="checkbox"/>
17	<p>Option K46 Sensor Module Cabinet-Mounted SMC10</p> <p>The SMC10 encoder module is used to simultaneously record the motor actual speed and the rotor position angle.</p> <p>The following encoders are supported by the SMC10 Sensor Module:</p> <ul style="list-style-type: none"> • Resolver, 2 pole • Resolver, multi-pole. <p>The motor temperature can also be detected using KTY84-130 or PTC thermistors (see section "Electrical installation / Other connections / Sensor Module Cabinet-Mounted SMC10 (Option K46)").</p>	<input type="checkbox"/> <input type="checkbox"/>
18	<p>Option K48 Sensor Module Cabinet-Mounted SMC20</p> <p>The SMC20 encoder module is used to simultaneously record the motor actual speed and the path angle.</p> <p>The following encoders are supported by the SMC20 Sensor Module:</p> <ul style="list-style-type: none"> • Incremental encoder sin/cos 1Vpp • Absolute encoder EnDat <p>The motor temperature can also be detected using KTY84-130 or PTC thermistors (see section "Electrical installation / Other connections / Sensor Module Cabinet-Mounted SMC20 (Option K48)").</p>	<input type="checkbox"/> <input type="checkbox"/>
19	<p>Option K50 Sensor Module Cabinet-Mounted SMC30</p> <p>The SMC30 Sensor Module is used for determining the actual motor speed.</p> <p>The following encoders are supported by the SMC30 Sensor Module:</p> <ul style="list-style-type: none"> • TTL encoder • HTL encoder • SSI encoder <p>The motor temperature can also be detected using KTY84-130 or PTC thermistors (see section "Electrical installation / Other connections / Sensor Module Cabinet-Mounted SMC30 (Option K50)").</p>	<input type="checkbox"/> <input type="checkbox"/>
Connecting protection and monitoring devices		
20	<p>Option L45 EMERGENCY OFF pushbutton installed in the cabinet door</p> <p>The contacts for the EMERGENCY OFF pushbutton are available at terminal -X120 and can be picked off so that they can be integrated in a higher-level line-side protection concept ("Electrical installation / Other connections / EMERGENCY OFF pushbutton, integrated in the door of the cabinet unit (option L45)").</p>	<input type="checkbox"/> <input type="checkbox"/>
21	<p>Option L57 EMERGENCY OFF category 0, 230 V AC or 24 V DC</p> <p>EMERGENCY OFF category 0 stops the drive in an uncontrolled manner. No additional wiring is necessary when implemented in conjunction with option L45.</p> <p>If the cabinet unit is integrated in an external safety circuit, however, the contact must be looped in via terminal block -X120 ("Electrical installation / Other connections / EMERGENCY OFF category 0, 230 V AC / 24 V DC (option L57)").</p>	<input type="checkbox"/> <input type="checkbox"/>

Item	Activity		Fulfilled/Complete	
22	Option L59 EMERGENCY STOP category 1, 230 V AC	EMERGENCY STOP category 1 stops the drive in a controlled manner. No additional wiring is necessary when implemented in conjunction with option L45. If the cabinet unit is integrated in an external safety circuit, however, the contact must be looped in via terminal block -X120. The timer relay -K121 must be adapted to match system requirements (see "Electrical installation / EMERGENCY STOP category 1, 230 V AC (option L59)").	<input type="checkbox"/>	<input type="checkbox"/>
23	Option L60 EMERGENCY STOP category 1, 24 V AC	EMERGENCY STOP category 1 stops the drive in a controlled manner. No additional wiring is necessary when implemented in conjunction with option L45. If the cabinet unit is integrated in an external safety circuit, however, the contact must be looped in via terminal block -X120. The timer relay at -K120 must be adapted to match system requirements (see "Electrical installation / Other connections / EMERGENCY STOP category 1, 24 V AC (option L60)").	<input type="checkbox"/>	<input type="checkbox"/>
24	Option L61/L62/L64/L65 25 kW/125 kW 50 kW/250 kW braking unit	The connecting cables and ground for the braking resistor must be connected to terminal block -X5: 1/2. A connection must be established between the braking resistor thermostatic switch and customer terminal block -A60. When commissioning via AOP30, the settings for evaluating "external fault 3" must be made. The settings for evaluating the thermostatic switch as "external fault 2" must be made (see "Electrical installation / Other connections / Braking unit 25 kW / 125 kW (option L61 / L64); braking unit 50 kW / 250 kW (option L62 / L65)").	<input type="checkbox"/>	<input type="checkbox"/>
25	Option L83 Thermistor motor protection device (alarm)	The PTC thermistor sensors (PTC resistor type A) must be connected to the thermistor motor protection unit -F127 at terminals T1 and T2 for alarms (see "Electrical installation / Other connections / Thermistor motor protection device (option L83/L84)").	<input type="checkbox"/>	<input type="checkbox"/>
26	Option L84 Thermistor motor protection device (shutdown)	The PTC thermistor sensors (PTC resistor type A) must be connected to the thermistor motor protection unit -F125 at terminals T1 and T2 for shutdown (see "Electrical installation / Other connections / Thermistor motor protection device (option L83/L84)").	<input type="checkbox"/>	<input type="checkbox"/>
27	Option L86 PT100 evaluation unit	The resistor thermometers must be connected to evaluation unit -B140 for the PT100 evaluation. A two-wire or three-wire system can be used here to connect the PT100 sensors. The sensors are divided into two groups (see "Electrical installation / Other connections / PT100 evaluation unit (option L86)"). This must be taken into account for the evaluation (factory setting).	<input type="checkbox"/>	<input type="checkbox"/>
28	Option L87 Insulation monitoring	The insulation monitor can only be operated from an insulated network. Only one insulation monitor can be used in an electrically-connected network. For line-side control, the signaling relays must be connected accordingly or, with individual drives (the cabinet unit is fed via a converter transformer assigned to the cabinet unit), integrated in the cabinet unit alarm train (see "Electrical installation / Other connections / Insulation monitoring (option L87)"). Point 7 must also be taken into account: "Before the cabinet is operated from an ungrounded supply/IT system, the connection bracket for the basic interference suppression device must be removed (see "Electrical installation / Removing the connection bracket for the interference suppression capacitor with operation from an ungrounded supply")".	<input type="checkbox"/>	<input type="checkbox"/>

4.2 Checklist for electrical installation

Item	Activity	Fulfilled/Complete	
Safety Integrated			
29	Option K82 "Safe Torque Off" and "Safe Stop 1" safety functions	The terminal block -X41 must be connected line-side, the safety functions must be activated prior to use via parameter assignment, in addition an acceptance test must be performed and an acceptance log must be created (see section "Electrical installation / Other connections / Terminal module for activating "Safe Torque Off" and "Safe Stop 1" (option K82)").	<input type="checkbox"/> <input type="checkbox"/>

Required tools

To install the connections, you will require:

- Spanner or socket spanner (w/f 10)
- Spanner or socket spanner (w/f 13)
- Spanner or socket spanner (w/f 16/17)
- Spanner or socket spanner (w/f 18/19)
- Hexagon-socket spanner (size 8)
- Torque wrench up to 50 Nm
- Screwdriver, size 2
- Screwdriver Torx T20
- Screwdriver Torx T30

4.3 Important safety precautions



WARNING

The cabinet units are operated with high voltages.
All connection procedures must be carried out when the cabinet is de-energized.
All work on the device must be carried out by trained personnel only.
Non-observance of these warning notices can result in death, severe personal injury or substantial property damage.

Work on an open device must be carried out with extreme caution because external supply voltages may be present. The power and control terminals may be live even when the motor is not running.

Dangerously high voltage levels are still present in the device up to five minutes after it has been disconnected due to the DC link capacitors. For this reason, the unit should not be opened until a reasonable period of time has elapsed.

Reforming the DC link capacitors:

The storage period should not exceed two years. If the device is stored for more than two years, its DC link capacitors must be reformed during commissioning.

The reforming procedure is described in "Maintenance and servicing".

The operator is responsible for ensuring that the motor, converter, and other devices are installed and connected in accordance with recognized engineering practice in the country of installation and in compliance with applicable regional regulations. Special attention should be paid to cable dimensioning, fuses, grounding, shutdown, disconnection, and overcurrent protection.

If an item of protective gear trips in a branch circuit, a fault current may have been disconnected. To reduce the risk of fire or an electric shock, the current-conducting parts and other components in the cabinet unit should be inspected and damaged parts replaced. When an item of protective gear trips, the cause of the trip must be identified and rectified.

Note

Standard cabinet units are equipped with touch protection to BGV A3 in accordance with DIN 57 106, Part 100/VDE 0106, Part 100 (Germany).

The version with option M60 features additional protective covers that offer a higher level of touch protection for current-conducting parts when the cabinet doors are open.

These protective covers may have to be removed during installation and connection procedures. Once work has been completed, the protective covers must be properly refitted.

Note

On ungrounded systems and systems with a grounded phase conductor and a line voltage >600 VAC, measures must be taken on the line side to limit overvoltages to overvoltage category II in accordance with IEC 60664-1.

CAUTION

Only original DRIVE-CLiQ cables may be used for wiring the DRIVE-CLiQ nodes.

4.4 Introduction to EMC

What is meant by EMC?

Electromagnetic compatibility (EMC) describes the capability of an electrical device to function satisfactorily in an electromagnetic environment without itself causing interference unacceptable for other devices in the environment.

EMC therefore represents a quality feature for the

- Internal noise immunity: Resistance to internal electrical disturbances
- External noise immunity: resistance against external electromagnetic disturbances
- Noise emission level: environmental effects caused by electromagnetic emissions

To ensure that the cabinet unit functions satisfactorily in the system, the environment subject to interference must not be neglected. For this reason, special requirements exist regarding the structure and the EMC of the system.

Operational reliability and noise immunity

In order to achieve the greatest possible operational reliability and immunity to noise of a complete system (converter, automation, drive machines etc.), measures must be taken by the converter manufacturer and the user. Only when all these measures are fulfilled can the faultless functioning of the converter be guaranteed and the specified legal requirements (2004/108/EC) be met.

Noise emissions

Product standard EN 61800 – 3 outlines the EMC requirements for variable-speed drive systems. It specifies requirements for converters with operating voltages of less than 1000 V. Different environments and categories are defined depending on where the drive system is installed.

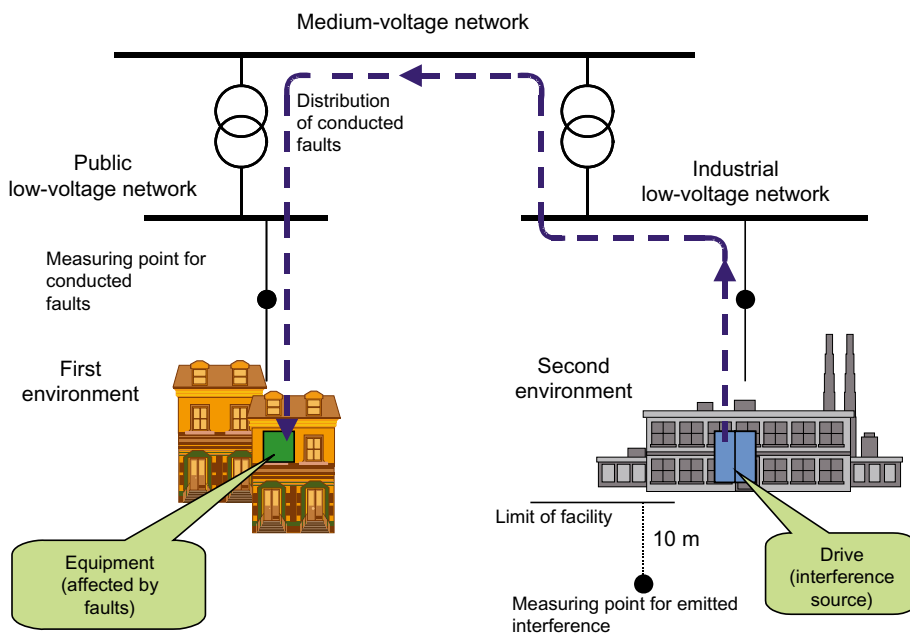


Figure 4-1 Definition of the first and second environments

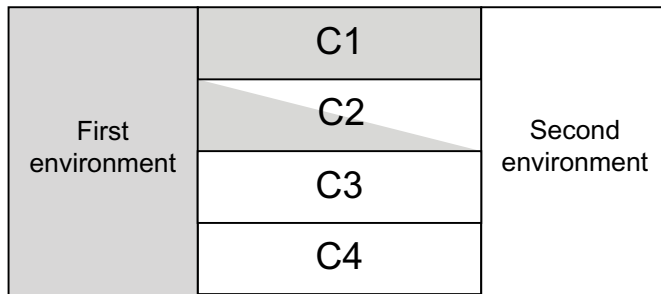


Figure 4-2 Definition of categories C1 to C4

Table 4- 1 Definition of the first and second environments

Definition of the first and second environments	
First environment	Residential buildings or locations at which the drive system is connected to a public low-voltage supply network without a transformer.
Second environment	Industrial locations supplied by a medium-voltage network via a separate transformer.

Table 4- 2 Definition of categories C1 to C4

Definition of categories C1 to C4	
Category C1	Rated voltage <1000 V; unrestricted use in the first environment.
Category C2	Rated voltage for stationary drive systems <1000 V; for use in the second environment. For use in the first environment only when sold and installed by skilled personnel.
Category C3	Rated voltage <1000 V; use in the second environment only.
Category C4	Rated voltage ≥ 1000 V or for rated currents ≥ 400 A in complex systems in the second environment.

4.5 EMC-compliant design

The following section provides some basic information and guidelines that will help you comply with the EMC and CE guidelines.

cabinet assembly

- Connect painted or anodized metal components using toothed self-locking screws or remove the insulating layer.
- Use unpainted, de-oiled mounting plates.
- Establish a central connection between ground and the protective conductor system (ground).

Shield gaps

- Bridge shield gaps (at terminals, circuit-breakers, contactors, and so on) with minimum impedance and the greatest possible surface area.

Using large cross-sections

- Use underground and grounding cables with large cross-sections or, better still, with litz wires or flexible cables.

Laying the motor supply cable separately

- The distance between the motor supply cable and signal cable should be > 20 cm. Do not lay signal cables and motor cables in parallel to each other.

Use anti-interference elements

- Lay an equalizing cable parallel to the control cable (the cable cross-section must be at least 16 mm²).
- If relays, contactors, and inductive or capacitive loads are connected, the switching relays or contactors must be provided with anti-interference elements.

Cable installation

- Cables that are subject to or sensitive to interference should be laid as far apart from each other as possible.
- All cables are to be laid as close as possible to grounded enclosure parts such as mounting plates or cabinet frames. This reduces both noise radiation and interference injection.
- Reserve cores of signal and data cables must be grounded at both ends to achieve an additional shielding effect.
- Long cables should be shortened or laid in noise resistant areas to avoid additional connecting points.

- If it is impossible to avoid crossing cables, conductors or cables that carry signals of different classes must cross at right angles, especially if they carry sensitive signals that are subject to interference.
 - Class 1:
unshielded cables for ≤ 60 V DC
unshielded cables for ≤ 25 V AC
shielded analog signal cables
shielded bus and data cables
operator panel interfaces, incremental/absolute encoder lines
 - Class 2:
unshielded cables for > 60 V DC and ≤ 230 V DC
unshielded cables for > 25 V AC and ≤ 230 V AC
 - Class 3:
unshielded cables for > 230 V AC/DC and ≤ 1000 V AC/DC

Shield connection

- Shields must not be used to conduct electricity. In other words, they must not simultaneously act as neutral or PE conductors.
- Apply the shield so that it covers the greatest possible surface area. You can use ground clamps, ground terminals, or ground screw connections.
- Avoid extending the shield to the grounding point using a wire (pigtail) because this will reduce the effectiveness of the shield by up to 90%.
- Attach the shield to a shield bar directly after the line inlet into the cabinet. Insulate the entire shielded cable and route the shield up to the device connection, but do not connect it again.

I/O interfacing

- Create a low-impedance ground connection for additional cabinets, system components, and distributed devices with the largest possible cross-section (at least 16 mm^2).
- Ground unused lines at one end in the cabinet.
- Choose the greatest possible clearance between the power and signal cables (at least 20 cm). The greater the distance over which the cables are routed in parallel, the greater the clearance must be. If a sufficient clearance cannot be maintained, you must install additional shields.
- Avoid unnecessarily long cable loops.


Filtering cables

- Line supply cables and power supply cables for devices and modules may have to be filtered in the cabinet to reduce incoming or outgoing disturbances.
- To reduce emissions, the device is equipped with a radio interference suppression filter as standard (in accordance with the limit values defined in category C3). Optional filters can be fitted for use in the first environment (category C2).

Protective ground conductors

- According to EN 61800-5-1, Section. 6.3.6.7, the minimum cross-section of the protective ground conductor must conform to the local safety regulations for protective ground conductors for equipment with a high leakage current.

4.6 Power connections

 WARNING
Swapping the input and output terminals can destroy the device!
Swapping or short-circuiting the DC link terminals can destroy the device!
The contactor and relay operating coils that are connected to the same supply network as the device or are located near the device must be connected to overvoltage limiters (e.g. RC elements).
The device must not be operated via a residual current operated device (DIN VDE 0160).

4.6.1 Connection cross-sections and cable lengths

Connection cross-sections

The connection cross-sections for the line connection, motor connection, and ground connection for your device are specified in the tables provided in the "Technical specifications" section.

Cable lengths

The maximum permissible cable lengths are specified for standard cable types or cable types recommended by SIEMENS. Longer cables can only be used after consultation.

The listed cable length represents the actual distance between the converter and the motor, taking account factors such as parallel laying, current-carrying capacity, and the laying factor.

- Unshielded cable (e.g. Protodur NYY): max. 450 m
- Shielded cable (e.g., Protodur NYCWY, Prototflex EMV 3 Plus): max. 300 m.

Note

The cable lengths specified are also valid if a motor choke is in use (option L08).

Note

The PROTOFLEX-EMV-3 PLUS shielded cable recommended by Siemens is the protective conductor and comprises three symmetrically-arranged protective conductors. The individual protective conductors must each be provided with cable eyes and be connected to ground. The cable also has a concentric flexible braided copper shield. To comply with EN61800-3 regarding radio interference suppression, the shield must contact at both ends and with the greatest possible surface area.

On the motor side, cable glands that contact the shield with the greatest possible surface area are recommended for the terminal boxes.

4.6.2 Connecting the motor and power cables

Connecting the motor and power cables on the cabinet unit

Note

The location of the connections is indicated in the layout diagrams provided in section 3.

1. Open the cabinet, remove the covers (if necessary) in front of the connection panel for motor cables (terminals U2/T1, V2/T2, W2/T3; X2) and power cables (terminals U1/L1, V1/L2, W1/L3; X1).
2. Move or remove the bottom plate below the connection panel in order to feed through the motor and power cables.
3. Screw the protective earth (PE) into the appropriate terminal (with earth symbol) (50 Nm for M12) at the points provided in the cabinet.
4. Connect the motor and power cables to the terminals.
Make sure that you connect the conductors in the correct sequence: U2/T1, V2/T2, W2/T3 and U1/L1, V1/L2, W1/L3.

CAUTION
Tighten the screws with the appropriate torque (50 Nm for M12), otherwise the terminal contacts could be destroyed by burning during operation.

Note

The motor ground must be fed back directly to the cabinet unit and connected.

Direction of motor rotation

With induction machines with a clockwise phase sequence (looking at the drive shaft), the motor must be connected to the cabinet unit as follows.

Table 4- 3 Cabinet unit and motor connection terminals

Cabinet unit (connection terminals)	Motor (connection terminals)
U2/T1	U
V2/T2	V
W2/T3	W

In contrast to the connection for the clockwise phase sequence, two phases have to be reversed with a counter-clockwise phase sequence (looking at the drive shaft).

Note

If an incorrect rotating field was connected when the cables were installed, and the rotating field cannot be corrected by swapping the motor cables, it can be corrected when commissioning the drive via p1821 (rotating field direction reversal) by changing the rotating field and thus enabling a direction reversal (see section "Functions, Monitoring and protective functions / Direction reversal").

With motors that can be operated in a star/delta configuration, the windings must be checked to ensure that they have been connected properly. Please refer to the relevant documentation for the motor and note the required insulation voltage for operating the cabinet unit.

4.6.3 Adjusting the fan voltage (-G1 -T10, -T1 -T10)

The power supply for the device fans (230 V 1 AC) in the Active Line Module (-G1 -T10) and in the Motor Module (-T1 -T10) is generated from the main supply system by means of transformers.

The locations of the transformers are indicated in the layout diagrams supplied.

The transformers are fitted with primary taps so that they can be fine-tuned to the rated supply voltage.

If necessary, the connection fitted in the factory, shown with a dashed line, must be reconnected to the actual line voltage.

Note

Two transformers (-G1 -T10 and -T20 or -T1 -T10 and -T20) are installed in the following cabinet units. The two primary terminals on these devices must be set together.

- With 380 V – 480 V 3 AC:
6SL3710-7LE36-1AA0, 6SL3710-7LE37-5AA0, 6SL3710-7LE38-4AA0, 6SL3710-7LE41-0AA0, 6SL3710-7LE41-2AA0, 6SL3710-7LE41-4AA0
 - With 500 V – 690 V 3 AC:
6SL3710-7LG34-1AA0, 6SL3710-7LG34-7AA0, 6SL3710-7LG35-8AA0, 6SL3710-7LG37-4AA0, 6SL3710-7LG38-1AA0, 6SL3710-7LG38-8AA0, 6SL3710-7LG41-0AA0, 6SL3710-7LG41-3AA0
-

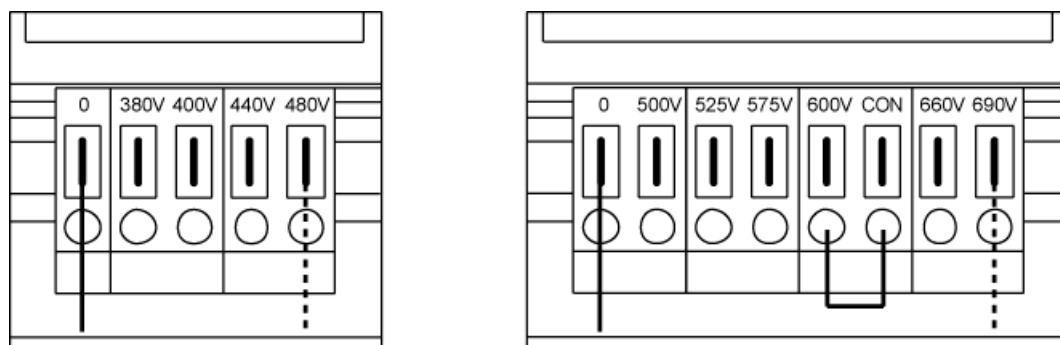


Figure 4-3 Setting terminals for the fan transformers (380 V – 480 V 3 AC / 500 V – 690 V 3 AC)

The line voltage assignments for making the appropriate setting on the fan transformer are indicated in the following tables.

Note

With the 500 V – 690 V 3 AC fan transformer, a jumper is inserted between the "600 V" terminal and "CON" terminal. The "600V" and "CON" terminals are for internal use.

NOTICE

If the terminals are not reconnected to the actual line voltage:

- The required cooling capacity cannot be provided because the fan rotates too slowly.
- The fan fuses may blow due to an overcurrent.

Note

The order numbers for fan fuses that have blown can be found in the spare parts list.

Table 4- 4 Line voltage assignments for setting the fan transformer (380 V – 480 V 3AC)

Line voltage	Taps of the fan transformer (-G1 -T10, -T1 -T10)
380 V ± 10%	380 V
400 V ± 10%	400 V
440 V ± 10%	440 V
480 V ± 10%	480 V

Table 4- 5 Line voltage assignments for setting the fan transformer (500 V – 690 V 3AC)

Line voltage	Taps of the fan transformer (-G1 -T10, -T1 -T10)
500 V ± 10%	500 V
525 V ± 10%	525 V
575 V ± 10%	575 V
600 V ± 10%	600 V
660 V ± 10%	660 V
690 V ± 10%	690 V

4.6.4 Adjusting the internal power supply (-A1-T10)

A transformer is installed in the Line Connection Module (-A1-T10) to produce the internal 230 V AC supply voltage for the cabinet unit. The location of the transformer is indicated in the layout diagrams supplied.

When delivered, the taps are always set to the highest level. The line-side terminals of the transformer may need to be reconnected to the existing line voltage.

The line voltage assignments for making the appropriate setting on the transformer for the internal power supply are indicated in the following tables.

NOTICE
If the terminals are not reconnected to the actual line voltage, the internal power supply will not be correct.

Table 4- 6 Line voltage assignments for the internal power supply (380 V – 480 V 3 AC)

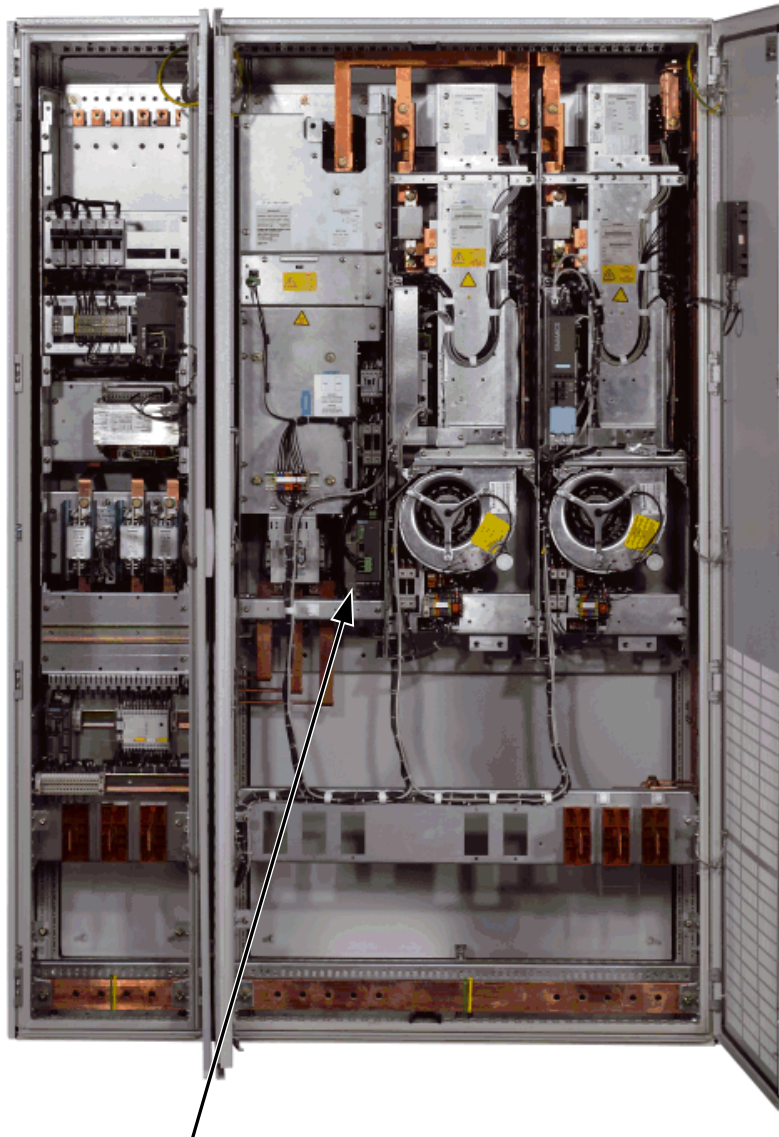
Line voltage range	Tap	Taps of voltage adaptation transformer (-A1-T10) LH1 – LH2
342 V – 390 V	380 V	1 - 2
391 V – 410 V	400 V	1 – 3
411 V – 430 V	415 V	1 – 4
431 V – 450 V	440 V	1 – 5
451 V – 470 V	460 V	1 – 6
471 V – 528 V	480 V	1 – 7

Table 4- 7 Line voltage assignments for the internal power supply (500 V – 690 V 3 AC)

Line voltage range	Tap	Taps of voltage adaptation transformer (-A1-T10) LH1 – LH2
450 V – 515 V	500 V	1 - 8
516 V – 540 V	525 V	1 – 9
541 V – 560 V	550 V	1 – 10
561 V – 590 V	575 V	1 – 11
591 V – 630 V	600 V	1 – 12
631 V – 680 V	660 V	1 – 14, terminals 12 and 13 are jumpered
681 V – 759 V	690 V	1 – 15, terminals 12 and 13 are jumpered


4.6.5 Removing the connection bracket for the interference-suppression capacitor with operation from an ungrounded supply

If the cabinet unit is operated from an ungrounded supply/IT system, the connection bracket for the interference-suppression capacitor of the active interface modules (-A2) must be removed.



Unscrew the 2 screws M4 (Torx T20) and remove the connection bracket.

Figure 4-4 Removing the connection bracket for the interference-suppression capacitor

 WARNING
Failing to remove the connection bracket for the interference-suppression capacitor on a non-grounded system/IT system can cause significant damage to the cabinet unit.

4.7 External supply of the auxiliary supply from a secure line

Description

An external auxiliary supply is always recommended if communication and closed-loop control are to be independent of the supply system. An external auxiliary supply is particularly recommended for low-power lines susceptible to short-time voltage dips or power failures.

With an external supply independent of the main supply, warnings and fault messages may still be displayed on the operator panel and internal protection and monitoring devices if the main supply fails.

 DANGER

When the external auxiliary supply is connected, dangerous voltages are present in the cabinet unit even when the main circuit breaker is open.

NOTICE

An external auxiliary supply (infeed) must always be used if the automatic restart (WEA) function is to be used with integrated EMERGENCY STOP option (L57, L59, L60). Otherwise, the automatic restart function does not work.

The maximum fuse rating is 16 A.

The connection is protected inside the cabinet with 5 A.

Connection

- On terminal block -X40, remove the jumpers between terminals 1 and 2 as well as 5 and 6.
- Connect the external 230 V AC supply to terminals 2 (L1) and 6 (N).

4.8 Signal connections

4.8.1 Customer terminal block (-A60)

Note

The factory setting and description of the customer terminal blocks can be found in the circuit diagrams.

The location of the customer terminal block in the cabinet unit is indicated in the layout diagram.

Shield connection

The shield connection of shielded control cables on the customer terminal block –A60 is established in the immediate vicinity of the terminal block. For this purpose, the customer terminal block –A60 and the mounting plates have cut-out sections which are used to snap the enclosed shield springs into place. The shields of incoming and outgoing cables must be applied directly to these shield connections. It is important here to establish the greatest possible area of contact and a good conductive connection.

Note

These shield springs can be used for all control cables in the cabinet unit because all the shield connections are identical in design.

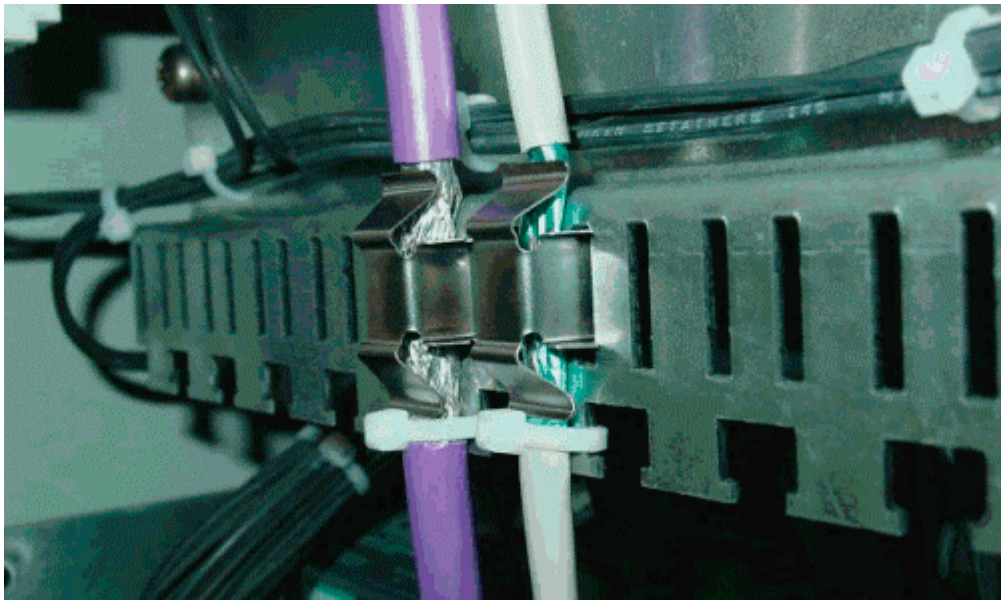


Figure 4-5 Shield connection

Overview

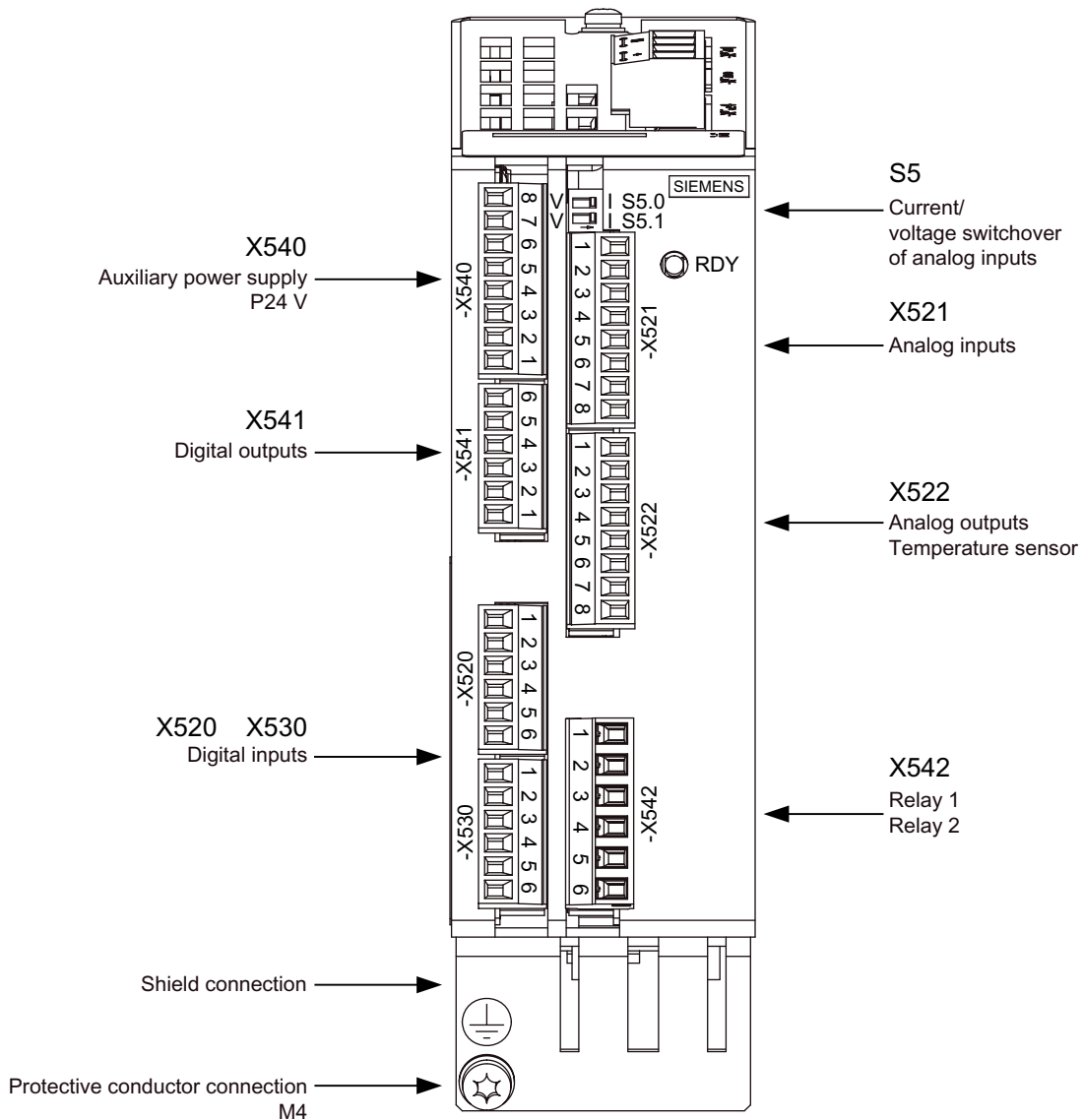


Figure 4-6 Customer terminal block TM31

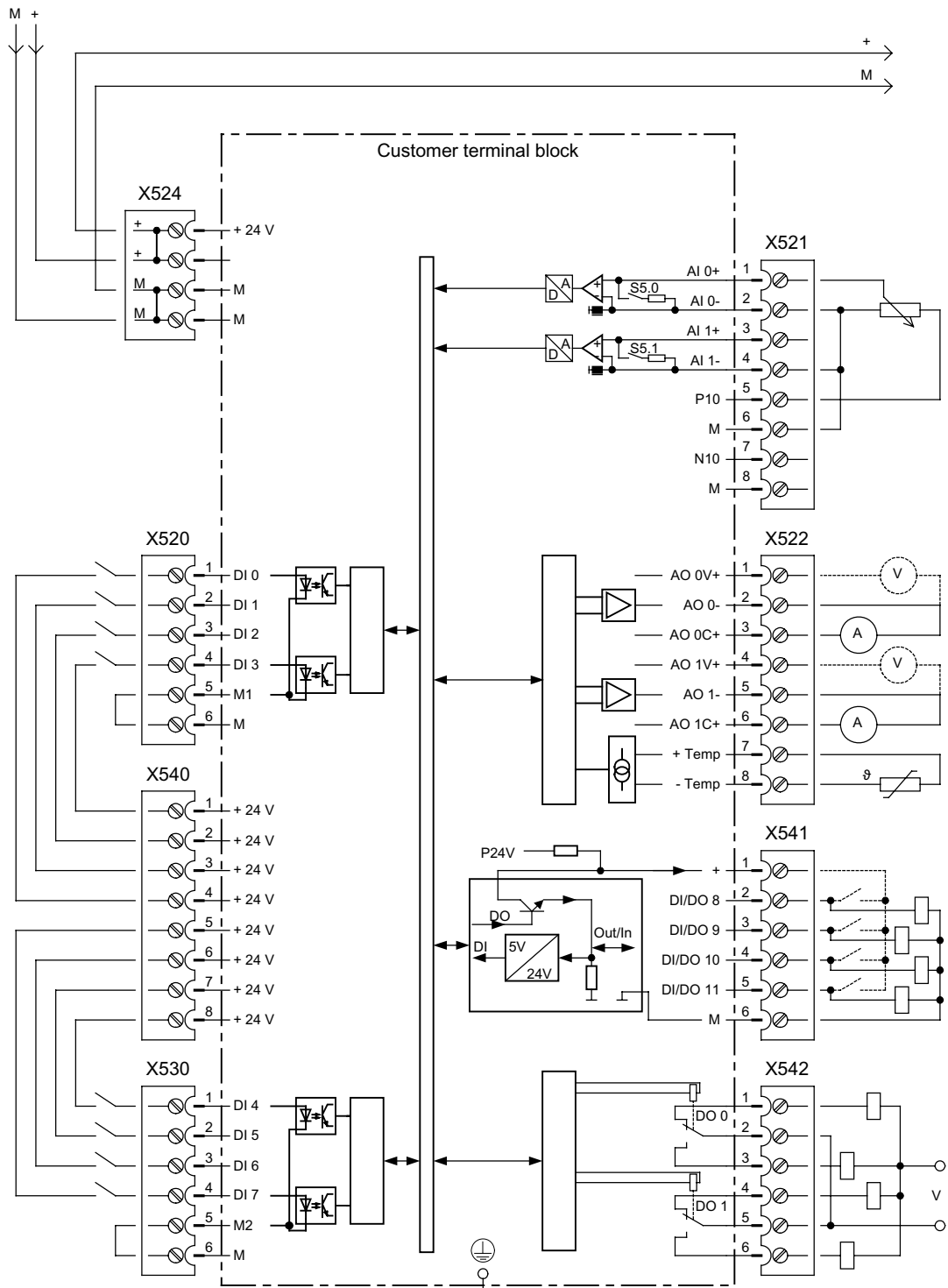


Figure 4-7 Connection overview of TM31 customer terminal block

Note

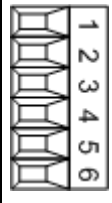
The digital inputs (terminals -X520 and -X530) in the example are powered by the internal 24 V supply of the customer terminal block (terminal -X540).

The two groups of digital inputs (optocoupler inputs) have a common reference potential for each group (ground reference M1 or M2). To close the circuit when the internal 24 V supply is used, the ground references M1 / M2 must be connected to internal ground (M).

If power is not supplied from the internal 24 V supply (terminal -X540), the jumper between ground M1 and M or M2 and M must be removed in order to avoid potential rounding. The external ground must then be connected to terminals M1 and M2.

X520: 4 digital inputs

Table 4- 8 Terminal block X520

	Terminal	Designation ¹⁾	Technical specifications
	1	DI 0	Voltage: - 3 V to 30 V Typical current consumption: 10 mA at 24 V Reference potential is always terminal M1 Level: - high level: 15 V to 30 V - low level: -3 V to 5 V
	2	DI 1	
	3	DI 2	
	4	DI 3	
	5	M1	Ground reference
	6	M	Electronics ground

¹⁾ DI: digital input; M1: ground reference; M: Electronics ground

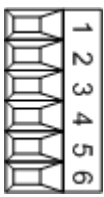
Max. connectable cross-section: 1.5 mm²

Note

An open input is interpreted as "low".

X530: 4 digital inputs

Table 4- 9 Terminal block X530

	Terminal	Designation ¹⁾	Technical specifications
	1	DI 4	Voltage: - 3 V to 30 V Typical current consumption: 10 mA at 24 V Reference potential is always terminal M2 Level: - high level: 15 V to 30 V - low level: -3 V to 5 V
	2	DI 5	
	3	DI 6	
	4	DI 7	
	5	M2	Ground reference
	6	M	Electronics ground

¹⁾ DI: digital input; M2: ground reference; M: Electronics ground

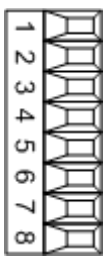
Max. connectable cross-section: 1.5 mm²

Note

An open input is interpreted as "low".

X521: 2 analog inputs (differential inputs)

Table 4- 10 Terminal block X521

	Terminal	Designation ¹⁾	Technical specifications
	1	AI 0+	As voltage input: -10 V - +10 V, Ri = 100 kΩ Resolution: 11 bits + sign As current input: +4 mA - +20 mA / -20 mA - +20 mA / 0 mA - +20 mA, Ri = 250 Ω Resolution: 10 bits + sign
	2	AI 0-	
	3	AI 1+	
	4	AI 1-	
	5	P10	Auxiliary voltage +10 V, continued short-circuit proof
	6	M	Ground reference
	7	N10	Auxiliary voltage -10 V, continued short-circuit proof
	8	M	Ground reference

¹⁾ AI: analog input; P10/N10: auxiliary voltage, M: Ground reference


Max. connectable cross-section: 1.5 mm²

CAUTION

The input current of the analog inputs must not exceed 35 mA when current measurements are performed.

S5: Selector for voltage/current AI0, AI1

Table 4- 11 Selector for voltage/current S5

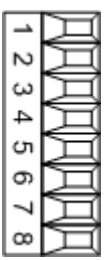
	Switch	Function
	S5.0	Selector voltage (V) / current (I) AI0
	S5.1	Selector voltage (V) / current (I) AI1

Note

When delivered, both switches are set to current measurement (switch set to "I").

X522: 2 analog outputs, temperature sensor connection

Table 4- 12 Terminal block X522

	Terminal	Designation ¹⁾	Technical specifications
	1	AO 0V+	-10 V - +10 V (max. 3 mA)
	2	AO 0-	+4 mA - +20 mA (max. load resistance ≤ 500 Ω)
	3	AO 0C+	-20 mA - +20 mA (max. load resistance ≤ 500 Ω)
	4	AO 1V+	0 mA - +20 mA (max. load resistance ≤ 500 Ω)
	5	AO 1-	Resolution: 11 bits + sign
	6	AO 1C+	continued short-circuit proof
	7	+Temp	Temperature sensor connection: KTY84-1C130 / PTC
	8	-Temp	

¹⁾ AO xV: analog output voltage; AO xC: Analog output current

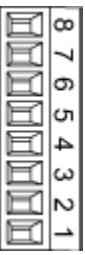
Max. connectable cross-section: 1.5 mm²

CAUTION

The permissible back EMF at the outputs is ±15 V

X540: Joint auxiliary voltage for the digital inputs

Table 4- 13 Terminal block X540

	Terminal	Designation	Technical specifications
	8	P24	24 V DC Max. total load current of +24 V auxiliary voltage of terminal blocks X540 and X541 combined: 150 mA continued short-circuit proof
	7	P24	
	6	P24	
	5	P24	
	4	P24	
	3	P24	
	2	P24	
	1	P24	


Max. connectable cross-section: 1.5 mm²

Note

This voltage supply is only for powering the digital inputs.

X541: 4 non-floating digital inputs/outputs

Table 4- 14 Terminal strip X541

	Terminal	Designation ¹⁾	Technical specifications
	6	M	Electronics ground
	5	DI/DO 11	As input: Voltage: -3 V to 30 V Typical current consumption: 10 mA at 24 V DC As output: The summation current of the four outputs (including the currents of the inputs) is limited to 100 mA (continued short-circuit proof) in the delivery condition.
	4	DI/DO 10	
	3	DI/DO 9	
	2	DI/DO 8	
	1	P24	

¹⁾ DI/DO: Digital input/output; M: Electronics ground

Max. connectable cross-section: 1.5 mm²

Note

An open input is interpreted as "low".


When externally generated 24 V DC signals are connected to a digital input, the ground reference of the external signal must also be connected.

CAUTION

Due to the limitation of the aggregate of the output currents an over-current can cause a short circuit on an output terminal or even intrusion of the signal of a different terminal.

X542: 2 relay outputs (two-way contact)

Table 4- 15 Terminal block X542

	Terminal	Designation ¹⁾	Technical specifications
	1	DO 0.NC	Contact type: Changeover contact max. load current: 8 A Max. switching voltage: 250 V AC, 30 V DC
	2	DO 0.COM	
	3	DO 0.NO	Max. switching voltage: - at 250 V AC: 2000 VA (cosφ = 1) - at 250 V AC: 750 VA (cosφ = 0.4) - at 30 V DC: 240 W (ohmic load)
	4	DO 1.NC	
	5	DO 1.COM	
	6	DO 1.NO	
			Required minimum current: 100 mA

¹⁾ DO: digital output, NO: normally-open contact, NC: normally-closed contact, COM: mid-position contact

Max. connectable cross-section: 2.5 mm²

Note

If 230 V AC is applied to the relay outputs, the Terminal Module must also be grounded via a 6 mm² protective conductor.

4.9 Other connections

Depending on the options installed, further connections have to be established, for example, dv/dt filter plus Voltage Peak Limiter, sine-wave filter, connection for external auxiliary equipment, main circuit-breaker including fuses or circuit-breaker, EMERGENCY OFF button, cabinet illumination with service socket, anti-condensation heating for cabinet, contactor combination (EMERGENCY OFF / EMERGENCY STOP), thermistor motor protection unit, braking unit, PT100 evaluation unit, insulation monitor, communication modules, encoder evaluator, and NAMUR option.

Detailed information on connecting individual options with interfaces can be found on the documentation CD.

4.9.1 dv/dt filter plus Voltage Peak Limiter (option L10)

Description

The dv/dt filter plus Voltage Peak Limiter comprises two components: the dv/dt reactor and the Voltage Peak Limiter, which limits transients and returns the energy to the DC link.

The dv/dt filters plus Voltage Peak Limiter must be used for motors for which the proof voltage of the insulation system is unknown or insufficient. Standard motors of the 1LA5, 1LA6 and 1LA8 series only require them at supply voltages $> 500\text{ V} + 10\%$.

The dv/dt filter plus Voltage Peak Limiter limits the voltage gradient to values $< 500\text{ V}/\mu\text{s}$ and the typical transients to the values below (with motor cable lengths of $< 150\text{ m}$):

- $< 1000\text{ V}$ at $U_{\text{line}} < 575\text{ V}$
- $< 1250\text{ V}$ at $660\text{ V} < U_{\text{line}} < 690\text{ V}$.

Depending on the converter power, option L10 can be accommodated in the drive converter cabinet unit or an additional cabinet with a width of 400 mm or 600 mm is required.

Table 4- 16 Accommodating the voltage limiting network in the cabinet or in an additional cabinet

Voltage range	Installation of the dv/dt filter plus Voltage Peak Limiter within the converter cabinet unit	Installation of the VPL in an additional cabinet, 400 mm width	Installation of the VPL in an additional cabinet, 600 mm width
380 V to 480 V 3 AC	6SL3710-7LE32-1AA0 6SL3710-7LE32-6AA0 6SL3710-7LE33-1AA0 6SL3710-7LE33-8AA0 6SL3710-7LE35-0AA0	6SL3710-7LE36-1AA0 6SL3710-7LE37-5AA0 6SL3710-7LE38-4AA0	6SL3710-7LE41-0AA0 6SL3710-7LE41-2AA0 6SL3710-7LE41-4AA0
500 V to 690 V 3 AC	6SL3710-7LG28-5AA0 6SL3710-7LG31-0AA0 6SL3710-7LG31-2AA0 6SL3710-7LG31-5AA0 6SL3710-7LG31-8AA0 6SL3710-7LG32-2AA0 6SL3710-7LG32-6AA0 6SL3710-7LG33-3AA0	6SL3710-7LG34-1AA0 6SL3710-7LG34-7AA0 6SL3710-7LG35-8AA0	6SL3710-7LG37-4AA0 6SL3710-7LG38-1AA0 6SL3710-7LG38-8AA0 6SL3710-7LG41-0AA0 6SL3710-7LG41-3AA0

Restrictions

The following restrictions should be noted when a dv/dt filter plus Voltage Peak Limiter is used:

- The output frequency is limited to no more than 150 Hz.
- Maximum permissible motor cable lengths:
 - Shielded cable: max. 300 m
 - Unshielded cable: max. 450 m

Commissioning

During commissioning, the dv/dt filter plus Voltage Peak Limiter must be logged on using STARTER or the AOP30 operator panel (p0230 = 2).

Note

When the factory settings are restored, parameter p0230 is reset. The parameter must be reset if the system is commissioned again.

4.9.2 Sine-wave filter (option L15)

Description

The sine-wave filter limits the voltage gradient and the capacitive charge/discharge currents which usually occur with inverter operation. It also prevents additional noise caused by the pulse frequency. The service life of the motor is as long as that attained with direct mains operation.

CAUTION

If a sine-wave filter is connected to the converter, the converter must be activated during commissioning to prevent the filter from being destroyed (see "Commissioning").

Restrictions

The following restrictions must be taken into account when a sine-wave filter is used:

- The output frequency is limited to no more than 150 Hz.
- The modulation type is permanently set to space-vector modulation without overmodulation.
- The maximum output frequency is limited to 85% of the input frequency.
- Maximum permissible motor cable lengths:
 - Unshielded cable: max. 450 m
 - Shielded cable: max. 300 m
- During commissioning, the pulse frequency rises to double the factory setting. This induces current derating, which must be applied to the cabinet unit rated currents listed in the technical specifications.

Note

If a filter cannot be parameterized (p0230 ≠ 3), this means that a filter has not been provided for the cabinet unit. In this case, the cabinet unit must not be operated with a sine-wave filter.

Table 4- 17 Technical specifications for sine-wave filters with SINAMICS S150

Order no. SINAMICS S150	Voltage [V]	Pulse frequency [kHz]	Output current [A] ¹⁾
6SL3710-7LE32-1AA0	3 AC 380 – 480	4	172 A
6SL3710-7LE32-6AA0	3 AC 380 – 480	4	216 A
6SL3710-7LE33-1AA0	3 AC 380 – 480	4	273 A
6SL3710-7LE33-8AA0	3 AC 380 – 480	4	331 A
6SL3710-7LE35-0AA0	3 AC 380 – 480	4	382 A

¹⁾ The values apply to operation with a sine-wave filter and do not correspond with the rated current on the type plate.

Commissioning

When commissioning using the STARTER or AOP30, the sine-wave filter must be activated by means of appropriate selection screenforms or dialog boxes (p0230 = 3), see section "Commissioning".

The following parameters are changed automatically during commissioning.

Table 4- 18 Parameter settings for sine-wave filters with SINAMICS S150

Parameter	Name	Setting
p0230	Drive filter type, motor side	3: Siemens sine-wave filter
p0233	Power unit motor reactor	Filter inductance
p0234	Power unit sine-wave filter capacitance	Filter capacitance
p0290	Power unit overload response	Disable pulse frequency reduction
p1082	Maximum speed	Fmax filter / pole pair number
p1800	Pulse frequency	Nominal pulse frequency of the filter (see previous table)
p1802	Modulator mode	Space-vector modulation without overmodulation
p1909	Motor data identification, control word	Rs measurement only

Note

When the factory settings are restored, parameter p0230 is reset.
The parameter must be reset if the system is commissioned again.

4.9.3 Connection for external auxiliary equipment (Option L19)

Description

This option includes an outgoing circuit fused at max. 10 A for external auxiliary equipment (e.g. separately-driven fan for motor). The voltage is tapped at the converter input upstream of the main contactor/circuit-breaker and, therefore, has the same level as the supply voltage. The outgoing circuit can be switched within the converter or externally.

Connection

Table 4- 19 Terminal block X155 - Connection for external auxiliary equipment

Terminal	Designation ¹⁾	Technical specifications
1	L1	380 - 480 V 3 AC 500 - 690 V 3 AC
2	L2	
3	L3	
11	Contactor control	230 V AC
12		
13	NO: Checkback motor circuit breaker	230 V AC / 0.5 A 24 V DC / 2 A
14		
15	NO: Checkback from contactor	240 V AC / 6 A
16		
PE	PE	PE

¹⁾ NO: NO contact

Max. connectable cross-section: 4 mm²

Note

The connection for external auxiliary equipment must be set in accordance with the connected consumer (-Q155).

Circuit proposal for controlling the auxiliary contactor from within the converter

The following circuit, for example, can be used if the auxiliary contactor is to be controlled from within the converter. The "Operation" message is then no longer available for other purposes.

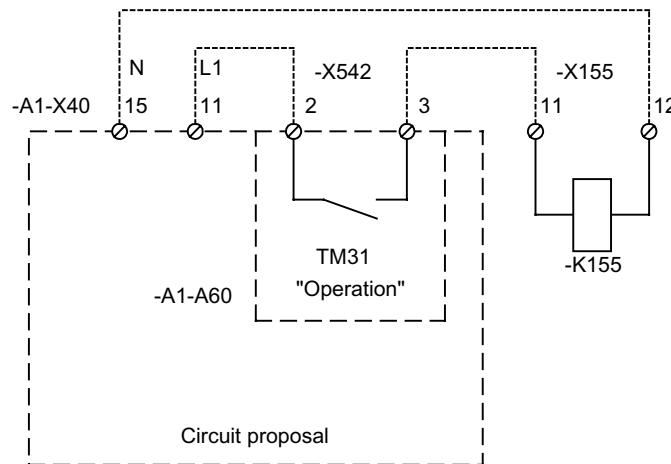


Figure 4-8 Circuit proposal for controlling the auxiliary contactor from within the converter

Note

If 230 V AC is applied to the relay outputs, the customer terminal block must also be grounded via a 6 mm² protective conductor.

4.9.4 Main switch incl. fuses or main circuit breaker (option L26)

Description

Up to 800 A, a load interrupter with externally-mounted fuses is used as the main circuit breaker. Above 800 A, the standard circuit breaker is used to disconnect the voltage and provide overload and short-circuit protection. The circuit breaker is controlled and supplied within the converter.

CAUTION

Switching at input

Cabinet units with circuit breaker may be powered up only once every 3 minutes. Failure to observe this rule can cause damage to the circuit breaker.


Connection

Table 4- 20 Terminal block X50 – checkback contact "main/circuit breaker closed"

Terminal	Designation ¹⁾	Technical specifications
1	NO	Max. load current: 10 A Max. switching voltage: 250 V AC Max. switching capacity: 250 VA Required minimum load: ≥ 1mA
2	NC	
3	COM	

¹⁾ NO: normally-open contact, NC: normally-closed contact, COM: mid-position contact
 Max. connectable cross-section: 4 mm²



 DANGER
At currents of more than 800 A and with a live line voltage, dangerous voltages are present in the cabinet unit even when the circuit breaker is open. The upstream protective gear must be de-energized when working on cabinets.

Setting the release current for the circuit breaker

In equipment with a circuit breaker, the release current must be set to match the plant requirements. The appropriate specifications are given in the operating instructions supplied with the circuit breaker.

The release current is set as follows per default:

Table 4- 21 Factory setting for overcurrent release

Order number	Output current	Overcurrent trip (L)	Short-circuit trip, non-delayed (I)
6SL3710-7LE38-4AA0	840 A	0,9	2
6SL3710-7LE41-0AA0	985 A	0,85	2
6SL3710-7LE41-2AA0	1260 A	0,8	2
6SL3710-7LE41-4AA0	1405 A	0,9	2
6SL3710-7LG38-1AA0	810 A	0,85	2
6SL3710-7LG38-8AA0	910 A	1,0	2
6SL3710-7LG41-0AA0	1025 A	0,9	2
6SL3710-7LG41-3AA0	1270 A	0,85	2

NOTICE
If the release current is not set correctly, the circuit breaker could trip inadvertently or even fail to trip.

Diagnostics

Messages output during operation and in the event of faults are described in "Additional Operating Instructions" of the Operating Instructions.

4.9.5 EMERGENCY OFF pushbutton installed in the cabinet door (option L45)

Description

The EMERGENCY OFF pushbutton with protective collar is integrated in the door of the cabinet unit. The contacts of the pushbutton are connected to terminal block –X120. In conjunction with options L57, L59, and L60, EMERGENCY OFF of category 0 and EMERGENCY STOP of category 1 can be activated.

Note

When the EMERGENCY OFF pushbutton is pressed, the motor coasts to a standstill and the main motor voltage is disconnected (to EN 60204-1 (VDE 0113)) in conjunction with options L57, L59 and L60. Auxiliary voltages (e.g. for separately-driven fans or anti-condensation heating) may still be present. Certain sections of the converter (e.g., the closed-loop controller or any auxiliary equipment) may also remain live. If all the voltages have to be completely disconnected, the EMERGENCY OFF pushbutton must be integrated in a protection concept, which must be implemented on the line side. For this purpose, an NC contact is installed at terminal block -X120.

Connection

Table 4- 22 Terminal block X120 –checkback contact "EMERGENCY OFF pushbutton in the cabinet door"

Terminal	Designation ¹⁾	Technical specifications
1	NC 1	Checkback contacts of EMERGENCY OFF pushbutton in cabinet door Max. load current: 10 A Max. switching voltage: 250 V AC Max. switching capacity: 250 VA Required minimum load: ≥1 mA
2		
3	NC 2 ²⁾	
4		

¹⁾ NC: normally-closed contact

²⁾ Factory setting in converter for options L57, L59, and L60

Max. connectable cross-section: 4 mm²

4.9.6 Cabinet illumination with service socket (option L50)

Description

A universal lamp with an integrated service socket is installed in each cabinet panel. The power supply for the cabinet illumination and socket must be provided externally and fused at max. 10 A. The cabinet illumination is switched on manually via a slide switch or automatically by means of an integrated motion detector (factory setting). The mode is selected via the switch on the light.

Connection

Table 4- 23 Terminal block X390 – connection for cabinet illumination with service socket

Terminal	Designation	Technical specifications
1	L1	230 V AC power supply
2	N	
3	PE	Protective conductor

Max. connectable cross-section: 4 mm²


4.9.7 Cabinet anti-condensation heating (option L55)

Description

The anti-condensation heating is used at low ambient temperatures and high levels of humidity to prevent condensation forming.

One 100 W heater is installed for a 400 mm and 600 mm cabinet panel, and two 100 W heaters for an 800/1000 and 1200 mm cabinet panel. The power supply for the heating (110 V – 230 V AC) must be provided externally and fused at max. 16 A.



 DANGER
When the supply voltage for the cabinet anti-condensation heating is connected, dangerous voltages are present in the cabinet unit even when the main circuit breaker is open.

Connection

Table 4- 24 Terminal block X240 – connection for cabinet anti-condensation heating

Terminal	Designation	Technical specifications
1	L1	110 V – 230 V AC Voltage supply
2	N	
3	PE	Protective conductor

Max. connectable cross-section: 4 mm²

4.9.8 EMERGENCY OFF category 0; 230 V AC or 24 V DC (option L57)

Description

EMERGENCY OFF category 0 for uncontrolled stop to EN 60204-1. This function involves disconnecting the cabinet unit from the supply via the line contactor bypassing the electronics by means of a safety combination to EN 60204-1. The motor then coasts to a stop. To prevent the main contactor from switching under load, an OFF2 is triggered simultaneously. The operational status is indicated by means of three LEDs (-K120).

In the factory setting, this version is set with a 230 V AC button circuit.

Note

When the EMERGENCY OFF button is pressed, the motor coasts to an uncontrolled standstill and the main motor voltage is disconnected (to EN 60204-1). Auxiliary voltages (e.g. for separately-driven fans or anti-condensation heating) may still be present. Certain sections of the converter (e.g., the closed-loop controller or any auxiliary equipment) may also remain live. If all the voltages have to be completely disconnected, the EMERGENCY OFF pushbutton must be integrated in a protection concept, which must be implemented on the line side. For this purpose, an NC contact is installed at terminal -X120.

Connection

Table 4- 25 Terminal block X120 – connection for EMERGENCY OFF category 0, 230 V AC and 24 V DC

Terminal	230 V AC and 24 V DC button circuit
4	Jumper wired in the factory
5	
7	Loop in EMERGENCY OFF button from line side, remove jumpers 7-8 and connect button
8	
9	Jumper wired in the factory
10	
11	Jumper wired in the factory
14	
12	Jumper wired in the factory
13	
15	"On" for monitored start: Remove jumpers 15-16 and connect button.
16	
17	NO ¹⁾ : Checkback "trip safety combination"
18	

¹⁾ NO: NO contact

Max. connectable cross-section: 4 mm²

Reconnection to the 24 V DC Button Circuit

When using the 24 V DC button circuit, you must remove the following jumpers at terminal block X120:

- 4-5, 9-10, and 11-14

You must also insert the following jumpers at terminal block X120:

- 4-11, 5-10, and 9-14

Diagnostics

Messages output during operation and in the event of faults (meaning of LEDs on -K120) are described in the "Additional Operating Instructions" of the Operating Instructions.

4.9.9 EMERGENCY STOP category 1; 230 V AC (option L59)

Description

EMERGENCY STOP category 1 for controlled stop to EN 60204-1. This function stops the drive by means of a quick stop along a deceleration ramp that must be parameterized. The cabinet unit is then disconnected from the power supply via the line contactor, which bypasses the electronics by means of a safety combination (to EN 60204-1). The operating status and the function are indicated by means of eight LEDs (-K120, -K121).

Connection

Table 4- 26 Terminal block X120 – connection for EMERGENCY STOP category 1 (230 V AC)

Terminal	Technical specifications
4	Jumper wired in the factory
5	
7	Loop in EMERGENCY OFF button from line side, remove jumpers 7-8 and connect button
8	
9	Jumper wired in the factory
10	
11	Jumper wired in the factory
14	
12	Jumper wired in the factory
13	
15	"On" for monitored start: Remove jumpers 15–16 and connect button.
16	
17	NO ¹⁾ : Checkback "trip safety combination"
18	

¹⁾ NO: NO contact

Max. connectable cross-section: 4 mm²

Setting

The time (0.5 to 30 s) set at the contactor safety combination (-K121) should be greater (or at least identical to) the time that the drive requires to reach standstill via quick stop (OFF3 ramp-down time, p1135), since the converter is disconnected from the power supply after expiry of the time (at -K121).

Diagnostics

Messages output during operation and in the event of faults (meaning of LEDs on -K120, -K121) are described in the "Additional Operating Instructions" of the Operating Instructions.

4.9.10 EMERGENCY STOP category 1; 24 V DC (option L60)

Description

EMERGENCY STOP category 1 for controlled stop to EN 60204-1. This function stops the drive by means of a quick stop along a deceleration ramp that must be parameterized. The cabinet unit is then disconnected from the power supply via the line contactor, which bypasses the electronics by means of a safety combination to EN 60204-1. The operating status and the function are indicated by means of five LEDs (-K120).

Connection

Table 4- 27 Terminal block X120 – connection for EMERGENCY STOP category 1 (24 V DC)

Terminal	Technical specifications
4	Jumper wired in the factory
11	
5	Jumper wired in the factory
10	
7	Loop in EMERGENCY OFF button from line side, remove jumpers 7-8 and connect button
8	
9	Jumper wired in the factory
14	
12	Jumper wired in the factory
13	
15	"On" for monitored start: Remove jumpers 15–16 and connect button.
16	
17	NO ¹⁾ : Checkback "trip safety combination"
18	

¹⁾ NO: NO contact

Max. connectable cross-section: 4 mm²

Setting

The time (0.5 to 30 s) set at the contactor safety combination (-K120) should be greater (or at least identical to) the time that the drive requires to reach standstill via quick stop (OFF3 ramp-down time, p1135), since the converter is disconnected from the power supply after expiry of the time (at -K120).

Diagnostics

Messages output during operation and in the event of faults (meaning of LEDs on -K120) are described in the "Additional Operating Instructions" of the Operating Instructions.

4.9.11 25 kW braking unit (option L61/L64); 50 kW braking unit (option L62/L65)

Description

Under normal circumstances, the braking energy is supplied back to the line. If a controlled stop is also required in the event of a power failure, however, additional braking units can be provided. The braking units comprise a chopper power unit and a load resistor, which must be attached externally. To monitor the braking resistance, a thermostatic switch integrated in the shutdown train of the cabinet unit is installed in the braking resistor.

Table 4- 28 Load data for the braking units

Line voltage	Continuous chopper power P_{DB}	Peak chopper output P_{15}	Chopper P_{20} output P_{20}	Chopper P_{40} output P_{40}	Braking resistor R_B	Max. current
380 V - 480 V	25 kW	125 kW	100 kW	50 kW	$4.4 \Omega \pm 7.5 \%$	189 A
380 V - 480 V	50 kW	250 kW	200 kW	100 kW	$2.2 \Omega \pm 7.5 \%$	378 A
500 V - 600 V	25 kW	125 kW	100 kW	50 kW	$6.8 \Omega \pm 7.5\%$	153 A
500 V - 600 V	50 kW	250 kW	200 kW	100 kW	$3.4 \Omega \pm 7.5\%$	306 A
660 V - 690 V	25 kW	125 kW	100 kW	50 kW	$9.8 \Omega \pm 7.5 \%$	127 A
660 V - 690 V	50 kW	250 kW	200 kW	100 kW	$4.9 \Omega \pm 7.5 \%$	255 A

4.9.11.1 Installing the braking resistor

Installing the braking resistor

The braking resistor should not be installed in the vicinity of the converter. The installation location must fulfill the following conditions:

- The braking resistors are only suitable for floor mounting.
- The maximum cable length between the cabinet unit and braking resistor is 100 m.
- Sufficient space must be available for dissipating the energy converted by the braking resistor.
- A sufficient distance from flammable objects must be maintained.
- The braking resistor must be installed as a free-standing unit.
- Objects must not be placed on or anywhere above the braking resistor.
- The braking resistor should not be installed underneath fire detection systems, since these could be triggered by the resulting heat.
- For outdoor installation, a hood should be provided to protect the braking resistor against precipitation (in accordance with degree of protection IP20).

CAUTION

A ventilation clearance of 200 mm must be maintained on all sides of the braking resistor (with ventilation grilles).

Table 4- 29 Dimensions of the braking resistors

	Unit	25 kW resistor (option L61/L64)	50 kW resistor (option L62/L65)
Width	mm	740	810
Height	mm	605	1325
Depth	mm	485	485

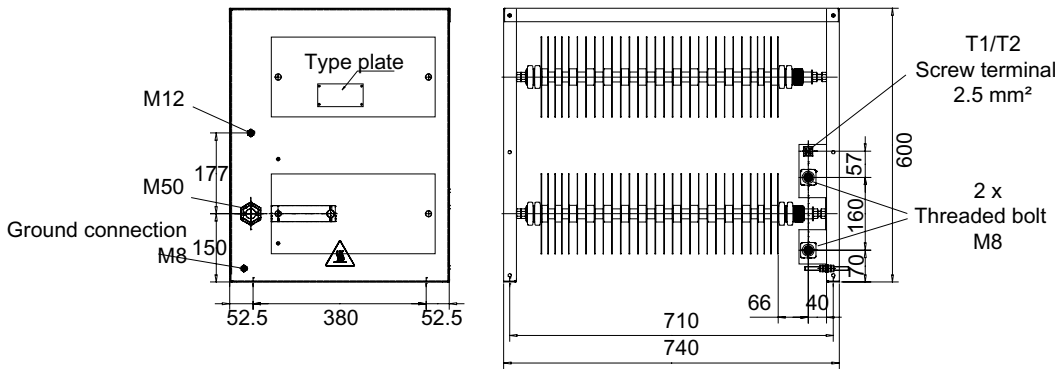


Figure 4-9 Dimension drawing for braking resistor (25 kW)

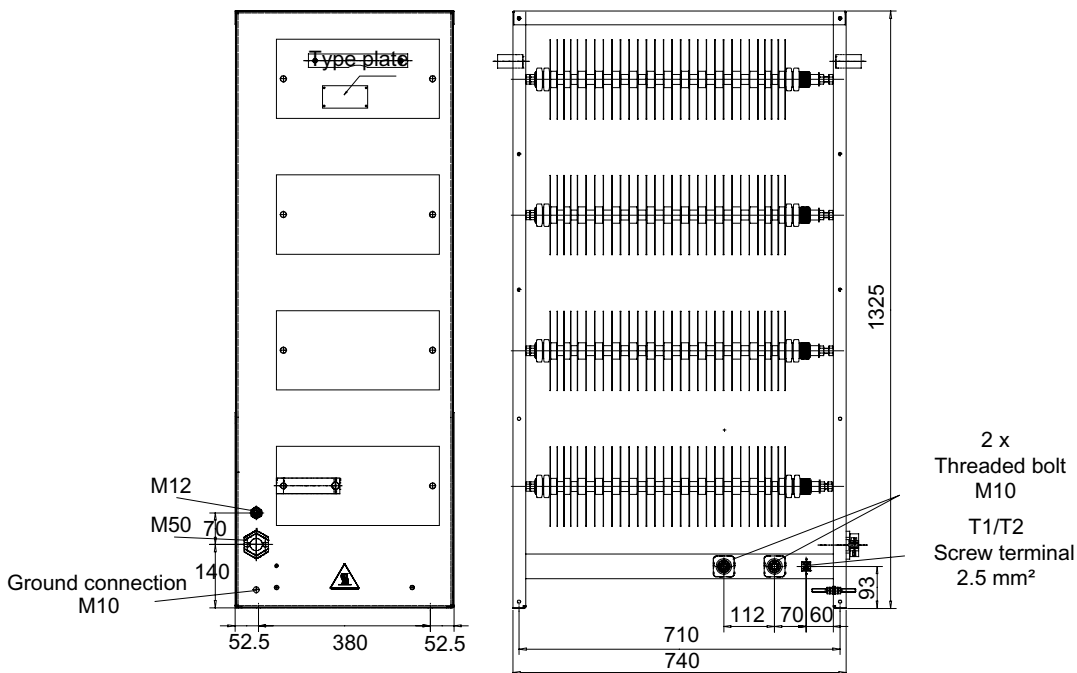



Figure 4-10 Dimension drawing for braking resistor (50 kW)

Connecting the braking resistor

 WARNING
The cables must only be connected to terminal block -X5 when the cabinet unit is switched off and the DC link capacitors are discharged.

CAUTION
The braking resistor cables must be laid in such a way that they are short-circuit and ground-fault proof.
The length of the connecting cables between the cabinet unit and external braking resistor must not exceed 100 m.

Table 4- 30 Terminal block -X5 – connection for external braking resistor

Terminal	Description of function
1	Braking resistor connection
2	Braking resistor connection

Max. connectable cross-section: 70 mm²

Recommended cable cross-sections:

- For L61/L64 (25 kW): 35 mm²
- For L62/L65 (50 kW): 50 mm²

Table 4- 31 Installing the thermostatic switch for the external braking resistor in the monitoring train of the cabinet unit

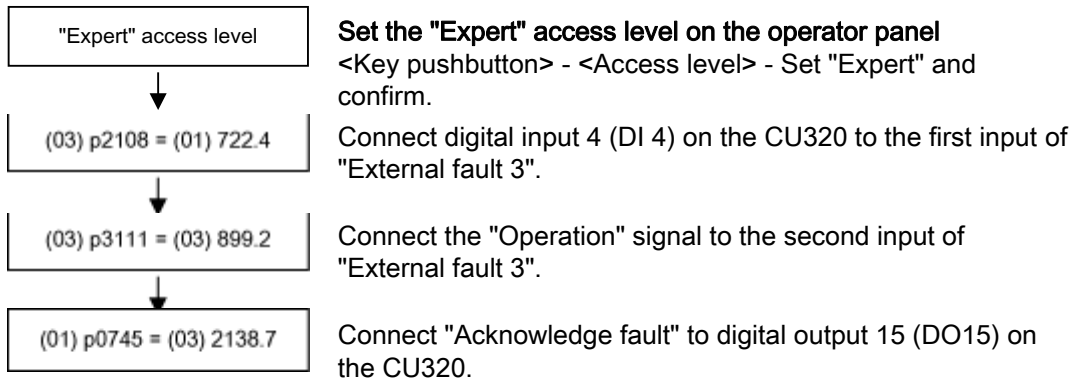
Terminal	Description of function
T1	Thermostatic switch connection: connection with terminal X541:1 (P24 V)
T2	Thermostatic switch connection: connection with terminal X541:5 (DI11)

Max. connectable cross-section (due to TM31): 1.5 mm²

Commissioning

When commissioning via STARTER, parameters are assigned to "external fault 3" and acknowledged automatically when option L61, L62, L64, or L65 is selected.

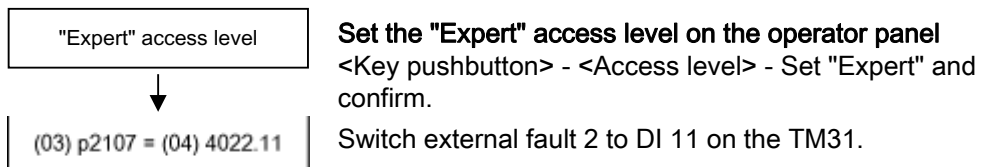
When commissioning via AOP30, the parameter entries required have to be set subsequently.



Cabinet unit settings

If the braking resistor thermostatic switch is connected to digital input 11 on the customer terminal block, appropriate settings have to be made so that the drive is brought to a standstill if a fault occurs.

Once the device has been successfully commissioned, you have to make the following changes:



Diagnosis

If the thermostat is opened due to a thermal overload on the braking resistor, fault F7861 ("External Fault 2") is triggered and the drive is switched off with OFF2.

If the brake chopper triggers a fault, fault F7862 "External fault 3" is triggered in the drive.

You can acknowledge malfunctions in the braking unit by pressing the "Acknowledge" button on the operator panel when the DC link voltage is present).

Duty cycles

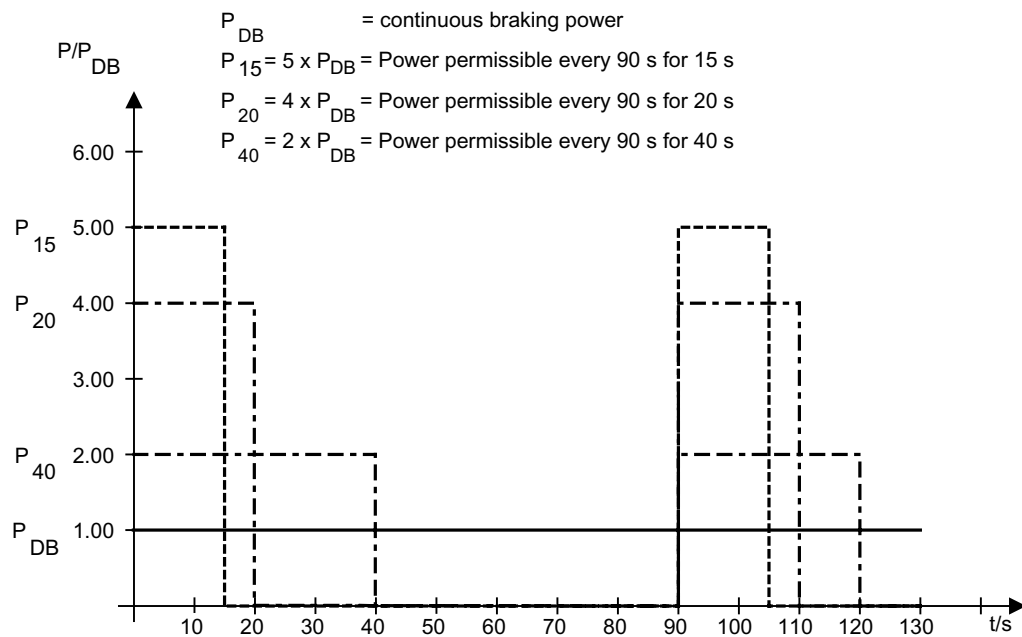


Figure 4-11 Duty cycles for the braking resistors

Threshold switch

The response threshold at which the braking unit is activated and the DC link voltage generated during braking are specified in the following table.

Note

Since the braking energy is normally supplied back to the line and the braking chopper is only to be activated in the event of a power failure, the default threshold value setting should be retained rather than reduced.

WARNING

The threshold switch must only be used when the cabinet unit is switched off and the DC link capacitors are discharged.

Table 4- 32 Response thresholds of the braking units

Rated voltage	Response threshold	Switch position	Remark
380 V - 480 V	673 V	1	774 V is the default factory setting. With supply voltages of between 380 V and 400 V, the response threshold can be set to 673 V to reduce the voltage stress on the motor and converter. This does, however, reduce the possible braking power with the square of the voltage $(677/774)^2 = 0.75$. The maximum possible braking power is, therefore, 75%.
	774 V	2	
500 V – 600 V	841 V	1	967 V is the default factory setting. With a supply voltage of 500 V, the response threshold can be set to 841 V to reduce the voltage stress on the motor and converter. This does, however, reduce the possible braking power with the square of the voltage $(841/967)^2 = 0.75$. The maximum possible braking power is, therefore, 75%.
	967 V	2	
660 V - 690 V	1070 V	1	1158 V is the default factory setting. With a supply voltage of 660 V, the response threshold can be set to 1070 V to reduce the voltage stress on the motor and converter. This does, however, reduce the possible braking power with the square of the voltage $(1070/1158)^2 = 0,85$. The maximum possible braking power is, therefore, 85 %.
	1158 V	2	

4.9.12 Thermistor motor protection unit (option L83/L84)

Description

This option includes the thermistor motor protection unit (with PTB approval) for PTC thermistor sensors (PTC resistor type A) for warning and shutdown. The power supply for the thermistor motor protection unit is provided inside the converter where the evaluation is also performed.

Option L83 triggers the "external alarm 1" (A7850) if a fault occurs.

Option L84 triggers the "external fault 1" (F7860) if a fault occurs.

Connection

Table 4- 33 F127/F125 – connection for thermistor motor protection unit

Equipment designation	Description of function
-F127: T1, T2	Thermistor motor protection (alarm)
-F125: T1, T2	Thermistor motor protection (shutdown)

The PTC thermistor sensors are connected directly to terminals T1 and T2 of the evaluation unit.

Table 4- 34 Maximum cable length for the sensor circuit

Line cross-section in mm ²	Line length in m
2,5	2 x 2800
1,5	2 x 1500
0,5	2 x 500

Diagnostics

Messages output during operation and in the event of faults (meaning of LEDs on -F125, F127) are described in the "Additional Operating Instructions" of the Operating Instructions.

4.9.13 PT100 evaluation unit (option L86)

Description

Note

The PT100 evaluation unit and the parameters for the measurement channels are described in the "Additional Operating Instructions".

4.9 Other connections

The PT100 evaluation unit can monitor up to six sensors. The sensors can be connected in a two or three-wire system. With the two-wire system, inputs Tx1 and Tx3 must be assigned. With the three-wire system, input Tx2 must also be connected (x = 1, 2, ...6). The limit values can be freely programmed for each channel. Shielded signal cables are recommended. If this is not possible, however, the sensor cables should at least be twisted in pairs.

In the factory setting, the measurement channels are divided into two groups of three channels. With motors, for example, this means that three PT100s in the stator windings and two PT100s in the motor bearings can be monitored. Unused channels can be suppressed via parameters.

The output relays are integrated in the internal fault and alarm train of the cabinet unit. The messages can also be picked up by the customer via two spare signaling relays. Two user-programmable analog outputs (0/4 to 20 mA and 0/2 to 10 V) are also available for integration in a higher-level controller. The power for the PT100 evaluation unit is supplied and the evaluation itself executed within the converter.

In the event of a fault, the "external alarm 1" (A7850) and "external fault 1" (F7860) are triggered.

Connection

Table 4- 35 Terminal block -A1-B140 – connection for evaluation unit PT100 resistors

Terminal	Designation	Technical specifications
T11-T13		90–240 V AC/DC; PT100; sensor 1; group 1
T21-T23		90–240 V AC/DC; PT100; sensor 2; group 1
T31-T33		90–240 V AC/DC; PT100; sensor 3; group 1
T41-T43		90–240 V AC/DC; PT100; sensor 1; group 2
T51-T53		90–240 V AC/DC; PT100; sensor 2; group 2
T61-T63		90–240 V AC/DC; PT100; sensor 3; group 2
51/52/54		90–240 V AC/DC Relay output limit value group 1 reached; (changeover contact)
61/62/64		90–240 V AC/DC Relay output limit value group 2 reached; (changeover contact)
Ground _	OUT 1	0/4–20 mA 0/2–10V Analog output out 1, sensor group 1
U1	OUT 1	
I1	OUT 1	
Ground _	OUT 2	0/4–20 mA 0/2–10V Analog output out 2, sensor group 2
U2	OUT 2	
I2	OUT 2	

Max. connectable cross-section: 2.5 mm²

Diagnostics

Messages output during operation and in the event of faults (meaning of LEDs on -B140) are described in the "Additional Operating Instructions" of the Operating Instructions.

4.9.14 Insulation monitor (option L87)

Description

In non-grounded systems (IT systems), the insulation monitor checks the entire electrically-connected circuit for insulation faults. The insulation resistance as well as all the insulation faults from the mains supply to the motor in the cabinet are detected. Two response values (between 1 k Ω and 10 M Ω) can be set. If a response value is undershot, an alarm is output to the terminal. A system fault is output via the signaling relay system.

When the cabinet unit is delivered, the plant configuration (one or several loads in one electrically-connected network) and the protection philosophy (immediate shutdown in the event of an insulation fault or restricted continued motion) can vary. This means that the signaling relays of the insulation monitor must be integrated by the customer in the fault and warning sequence.

Safety information

NOTICE
Only one insulation monitor can be used within the same electrically-connected network.

Note

When the insulation monitor is used, the connection bracket for the interference suppression capacitor must be removed (see "Electrical installation / Removing the connection bracket for the interference suppression capacitor with operation from an ungrounded supply").

Controls and displays on the insulation monitor

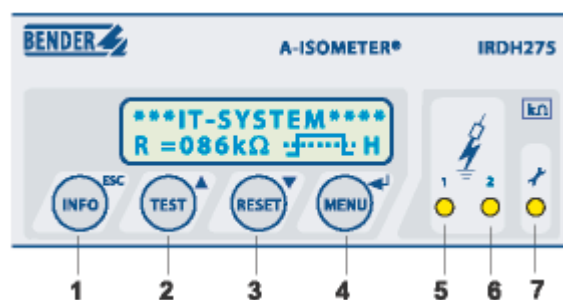


Figure 4-12 Controls and displays on the insulation monitor

Table 4- 36 Meaning of the controls and displays on the insulation monitor

Position	Meaning
1	INFO key: To request standard information/ ESC key: Back menu function
2	TEST key: Call up self-test Arrow key up: Parameter change, scroll
3	RESET button: Delete insulation and fault messages Arrow key down: Parameter change, scroll
4	Menu key: Call up menu system Enter key: Confirm parameter change
5	Alarm LED 1 lights up: Insulation fault, first alarm threshold reached
6	Alarm LED 2 lights up: Insulation fault, second alarm threshold reached
7	LED lights up: System error present

Connection

Table 4- 37 Connections on insulation monitor

Terminal	Technical specifications
A1	Supply voltage via 6 A melting fuse: 88 to 264 V AC, 77 to 286 V DC
A2	
L1	Connection of the 3 AC system to be monitored
L2	
AK	Connection to coupling device
KE	PE connection
T1	External test button
T2	External test button
R1	External reset key (NC contact or wire jumper otherwise the fault code is not stored)
R2	External reset key (NC contact or wire jumper)
F1	STANDBY with aid of F1, F2 function input:
F2	
M+	External kΩ display, analog output (0 μA ... 400 μA)
M-	External kΩ display, analog output (0 μA ... 400 μA)
A	Serial interface RS 485 (termination by means of 120 ohm resistor)
B	
11	Signaling relay ALARM 1 (mid-position contact)
12	Signaling relay ALARM 1 (NC contact)
14	Signaling relay ALARM 1 (NO contact)
21	Signaling relay ALARM 2 (mid-position contact)
22	Signaling relay ALARM 2 (NC contact)
24	Signaling relay ALARM 2 (NO contact)

Max. connectable cross-section: 2.5 mm²

Diagnostics

Messages output during operation and in the event of faults (meaning of LEDs on -B101) are described in the "Additional Operating Instructions" of the Operating Instructions.

4.9.15 Communication Board Ethernet CBE20 (option G33)

Description

Interface module CBE20 is used for communication via PROFINET.

The module is delivered mounted in a supplementary pack on the CU320 Control Unit and must be installed line-side in the option slot of the CU320 Control Unit.

4 Ethernet interfaces are available on the module. Diagnosis of the function mode and communication are possible via LEDs.

Interface overview

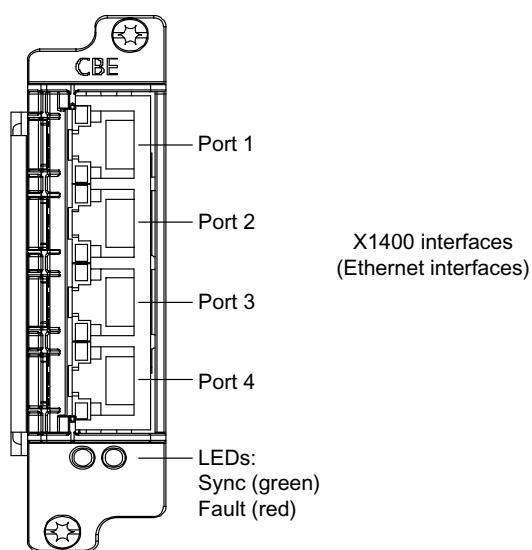


Figure 4-13 Communication Board Ethernet CBE20

MAC address

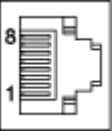
The MAC address of the Ethernet interfaces is indicated on the upper side of the CBE20. The plate is no longer visible after installation.

Note

Please note the MAC address prior to installing the module so that it is available to you for the subsequent commissioning.

X1400 Ethernet interface

Table 4- 38 Connector X1400, port 1 - 4

	Pin	Signal name	Technical specifications
	1	RX+	Receive data +
	2	RX-	Receive data -
	3	TX+	Transmit data +
	4	---	Reserved, do not use
	5	---	Reserved, do not use
	6	TX-	Transmit data -
	7	---	Reserved, do not use
	8	---	Reserved, do not use
	Screened backshell	M_EXT	Screen, permanently connected

Assembly

CAUTION
The Option Board should only be inserted and removed when the Control Unit and Option Board are disconnected from the power supply.

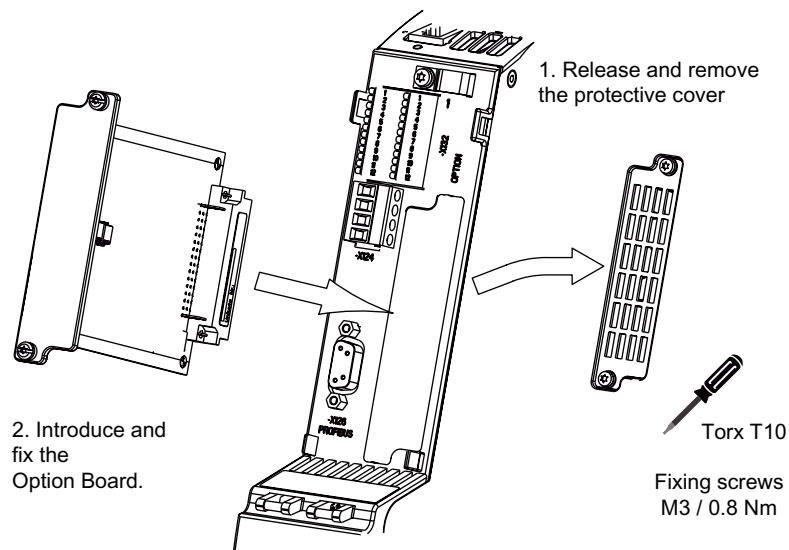


Figure 4-14 Mounting the CBE20

4.9.16 CBC10 CAN Communication Board (option G20)

Description

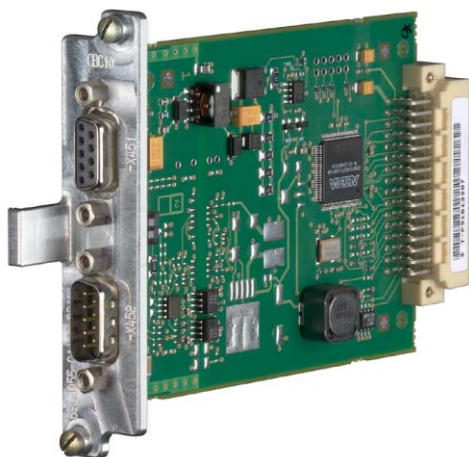


Figure 4-15 CAN CBC10 Communication Board

The CBC10 CANopen communication board (CAN Communication Board) is used to connect drives in the SINAMICS drive system to higher-level automation systems with a CAN bus.

The CANopen Option Board uses two 9-pin sub D connectors for the connection to the CAN bus system.

The connectors can be used as inputs or outputs. Unused pins are plated through.

Among others, the following transmission rates are supported: 10, 20, 50, 125, 250, 500, 800 kBaud, and 1 Mbaud.

CAUTION

The Option Board should only be inserted and removed when the Control Unit and Option Board are disconnected from the power supply.

The CBC10 must only be operated by qualified personnel. The ESD notices must be observed.

Note

Detailed and comprehensive instructions and information for the CBC10 Communication Board can be found in the accompanying Operating Instructions. These Operating Instructions are available as additional documentation on the enclosed customer CD.

Interface overview

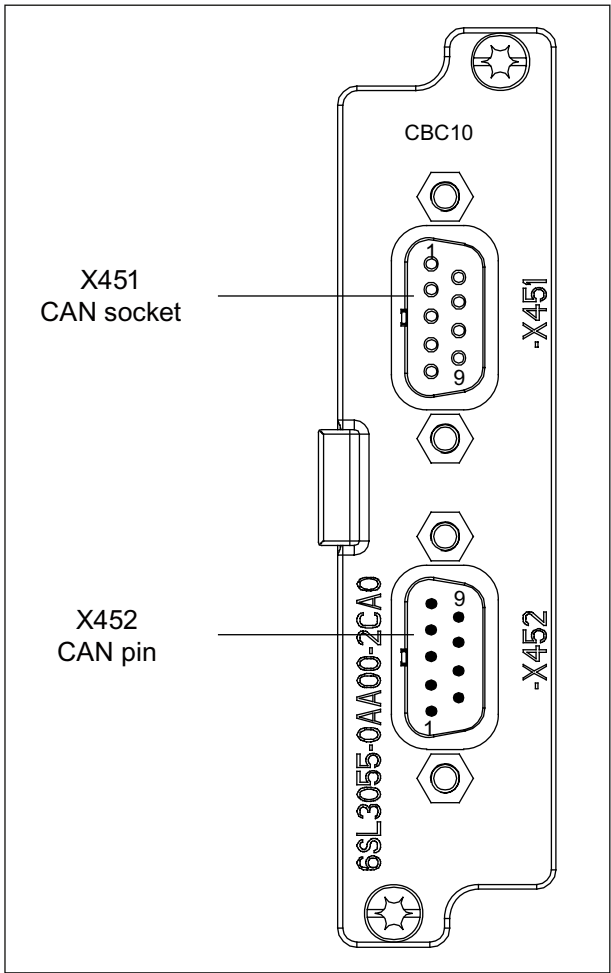
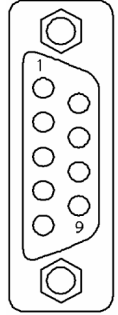


Figure 4-16 CAN CBC10 Communication Board

CAN bus interface -X451

CAN bus interface -X451 features the following socket assignments:

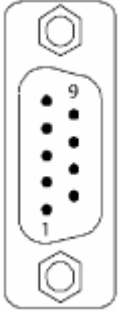
Table 4- 39 CAN bus interface -X451

	Pin	Designation	Technical specifications
	1	Reserved	
	2	CAN_L	CAN signal (dominant low)
	3	CAN_GND	CAN ground
	4	Reserved	
	5	CAN_SHLD	Optional shield
	6	GND	CAN ground
	7	CAN_H	CAN signal
	8	Reserved	
	9	Reserved	
Type: 9-pin sub D socket			

CAN bus interface -X452

CAN bus interface -X452 features the following socket assignments:

Table 4- 40 CAN bus interface -X452

	Pin	Designation	Technical specifications
	1	Reserved	
	2	CAN_L	CAN signal (dominant low)
	3	CAN_GND	CAN ground
	4	Reserved	
	5	CAN_SHLD	Optional shield
	6	GND	CAN ground
	7	CAN_H	CAN signal
	8	Reserved	
	9	Reserved	
Type: 9-pin sub D pin			

Note

Detailed and comprehensive instructions and information for the CANopen interface can be found in the accompanying Function Manual. This manual is available as additional documentation on the accompanying customer CD.

4.9.17 SMC10 Sensor Module Cabinet-Mounted (option K46)

4.9.17.1 Description

The SMC10 Sensor Module is used for determining the actual motor speed and the rotor position angle. The signals received from the resolver are converted here and made available to the closed-loop controller via the DRIVE-CLiQ interface for evaluation purposes.

The following encoders can be connected to the SMC10 Sensor Module:

- Resolver 2 pole
- Multipole resolver

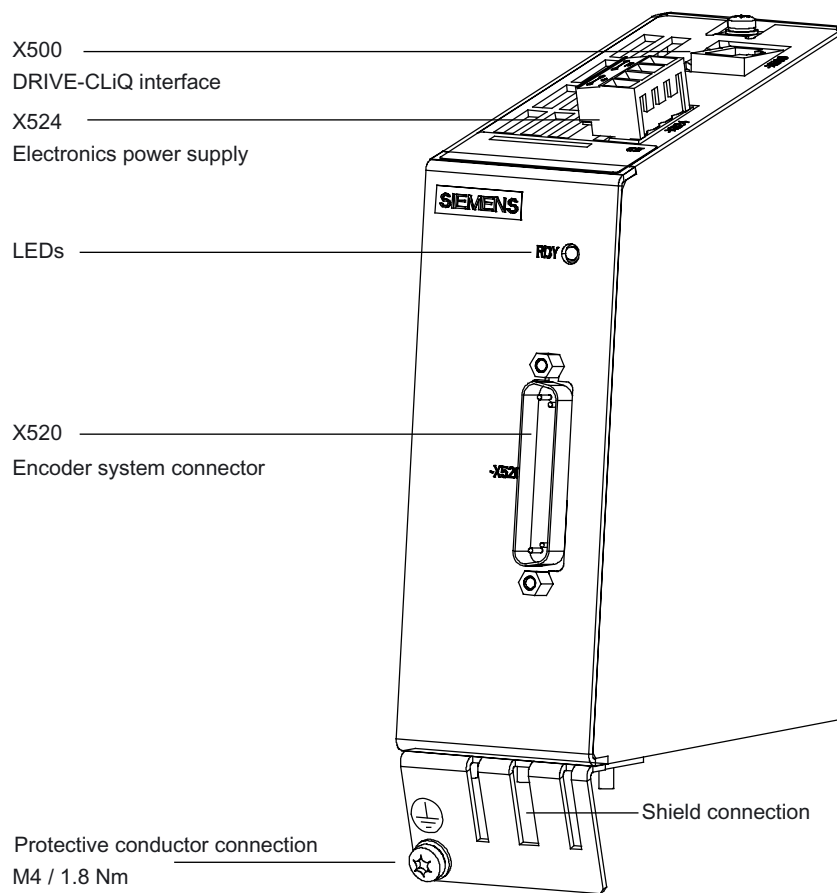
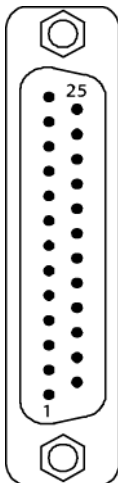


Figure 4-17 SMC10 Sensor Module

4.9.17.2 Connection

X520: Encoder connection

Table 4- 41 Encoder connection X520

	Pin	Signal name	Technical specifications
	1	Reserved, do not use	
	2	Reserved, do not use	
	3	A (sin+)	Resolver signal A
	4	A* (sin-)	Inverted resolver signal A
	5	Ground	Ground (for internal shield)
	6	B (cos+)	Resolver signal B
	7	B* (cos-)	Inverted resolver signal B
	8	Ground	Ground (for internal shield)
	9	RESP	Resolver excitation positive
	10	Reserved, do not use	
	11	RESN	Resolver excitation negative
	12	Reserved, do not use	
	13	+ Temp	Motor temperature measurement KTY
	14	Reserved, do not use	
	15	Reserved, do not use	
	16	Reserved, do not use	
	17	Reserved, do not use	
	18	Reserved, do not use	
	19	Reserved, do not use	
	20	Reserved, do not use	
	21	Reserved, do not use	
	22	Reserved, do not use	
	23	Reserved, do not use	
	24	Ground	Ground (for internal shield)
	25	- Temp	Motor temperature measurement KTY

Connector type: 25-pin Sub D connector (pin)

Note

The maximum signal cable length is 130 m.

4.9.17.3 Connection example

Connection example: Resolver, 8 pole

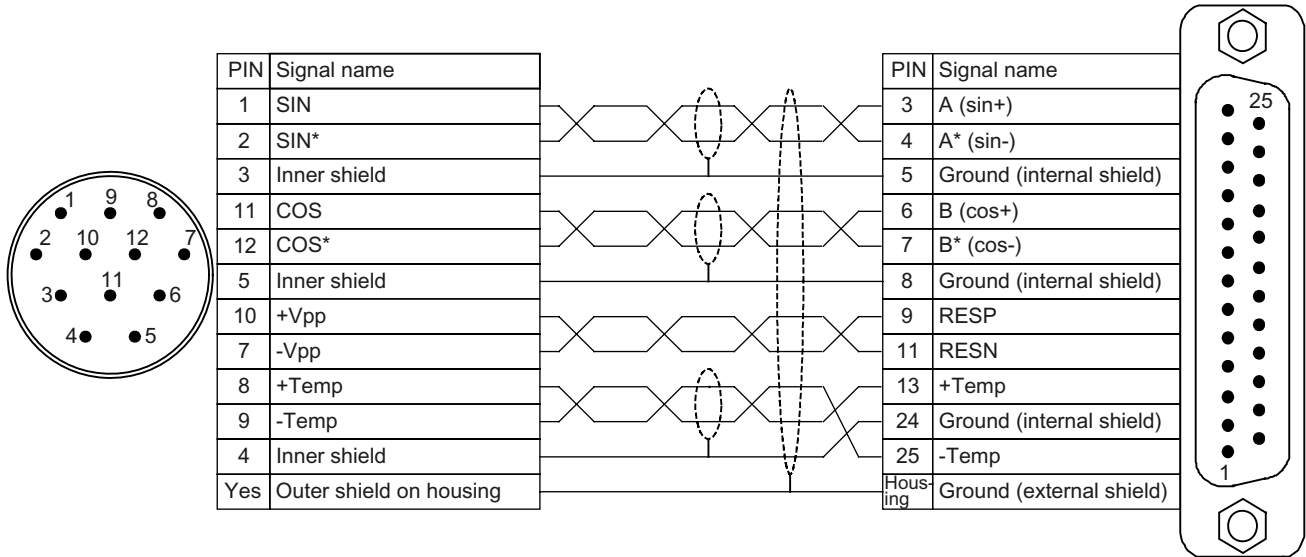


Figure 4-18 Connection example: Resolver, 8 pole

Parameter settings

Table 4- 42 Parameter settings for 8-pole resolver on SMC10

Parameter	Name	Value
p0400[0]	Enc type selection	Resolver 4 speed (1004)
p0404[0]	Encoder configuration effective	800010(hex)
p0404[0].0	Linear encoder	No
p0404[0].1	Absolute encoders	No
p0404[0].2	Multiturn encoder	No
p0404[0].3	Track A/B square-wave	No
p0404[0].4	Track A/B sinusoidal	Yes
p0404[0].5	Track C/D	No
p0404[0].6	Hall sensor	No
p0404[0].8	EnDat encoder	No
p0404[0].9	SSI encoder	No
p0404[0].12	Equidistant zero mark	No
p0404[0].13	Irregular zero mark	No
p0404[0].14	Distance-coded zero mark	No
p0404[0].15	Commutation with zero mark	No
p0404[0].16	Acceleration	No
p0404[0].20	Voltage level 5 V	No
p0404[0].21	Voltage level 24 V	No
p0404[0].22	Remote sense (only SMC30)	No
p0404[0].23	Resolver excit.	Yes
p0405[0]	Square-wave signal encoder A/B track	0(hex)
p0408[0]	Rotary encoder pulse No.	4

4.9.18 SMC20 Sensor Module Cabinet-Mounted (option K48)

4.9.18.1 Description

Description

The SMC20 Sensor Module is used for determining the actual motor speed and the path length. The signals emitted by the rotary pulse encoder are converted here and made available to the closed-loop controller via the DRIVE-CLiQ interface for evaluation purposes.

The following encoders can be connected to the SMC20 Sensor Module:

- Incremental encoder sin/cos 1Vpp
- Absolute value encoder for EnDat and SSI (with 5 V operating voltage)

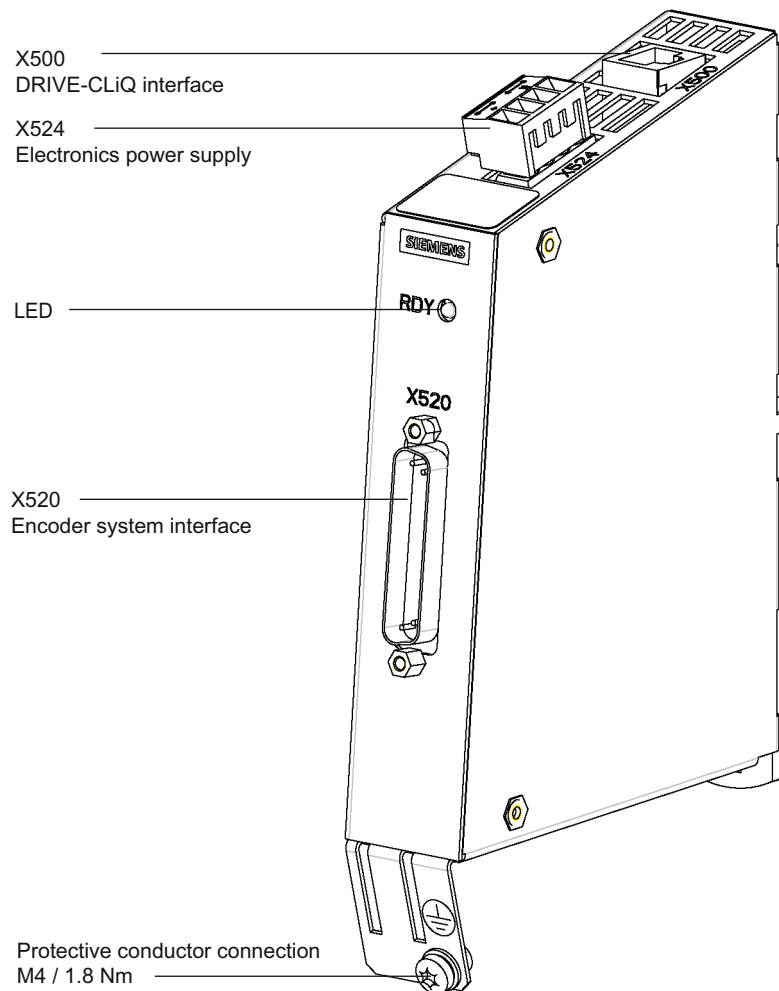
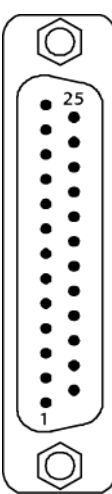


Figure 4-19 SMC20 Sensor Module

4.9.18.2 Connection

X520: Encoder connection

Table 4- 43 Encoder connection X520

	Pin	Signal name	Technical specifications
	1	P encoder	Encoder supply
	2	M encoder	Ground for encoder power supply
	3	A	Incremental signal A
	4	A*	Inverted incremental signal A
	5	Ground	Ground (for internal shield)
	6	B	Incremental signal B
	7	B*	Inverted incremental signal B
	8	Ground	Ground (for internal shield)
	9	Reserved, do not use	
	10	EnDat_Clock, SSI_Clock	Clock, EnDat interface, SSI clock
	11	Reserved, do not use	
	12	EnDat_Clock*, SSI_Clock*	Inverted clock, EnDat interface, inverted SSI clock
	13	+ Temp	Motor temperature measurement KTY+/PTC
	14	5 V sense	Sense input encoder power supply
	15	EnDat_Data, SSI_Data	Data, EnDat interface, SSI data
	16	0 V Sense	Ground sense input encoder power supply
	17	R	Reference signal R
	18	R*	Inverted reference signal R
	19	C	Absolute track signal C
	20	C*	Inverted absolute track signal C
	21	D	Absolute track signal D
	22	D*	Inverted absolute track signal D
	23	EnDat_Data*, SSI_Data*	Inverted data, EnDat interface, inverted SSI data
	24	Ground	Ground (for internal shield)
	25	- Temp	Motor temperature measurement KTY-/PTC

Connector type: 25-pin Sub D connector (pin)

Note

The maximum signal cable length is 100 m.

4.9.18.3 Connection example

Connection example: Incremental encoder sin/cos 1 Vpp, 2048

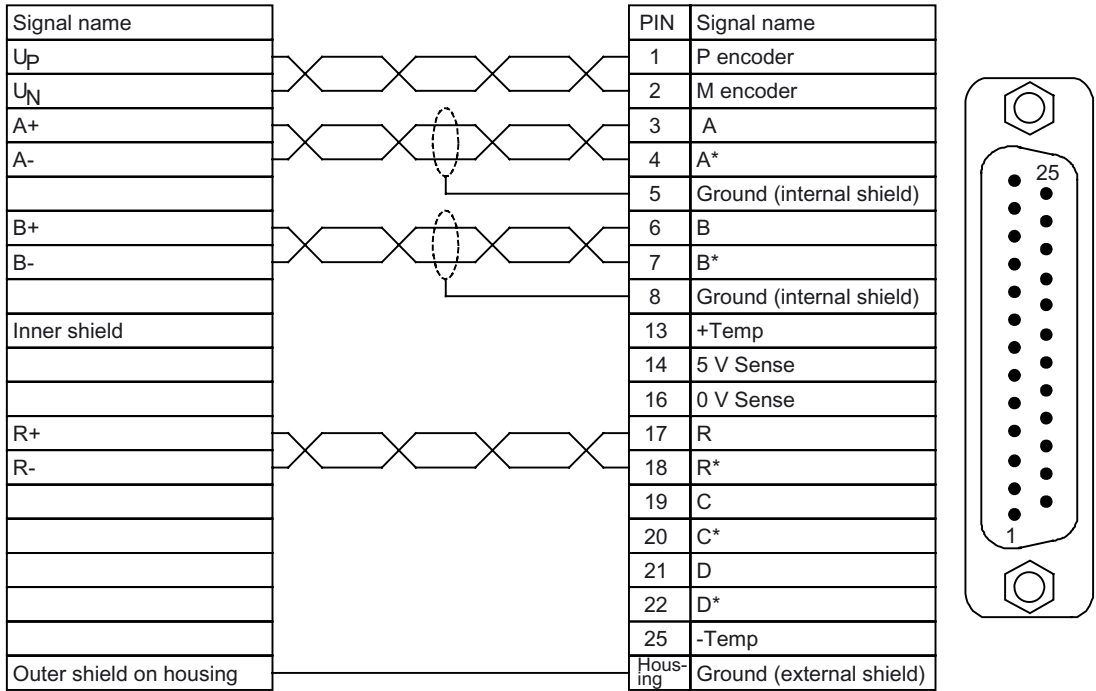


Figure 4-20 Connection example: Incremental encoder sin/cos 1 Vpp, 2048

Parameter settings

Table 4- 44 Parameter settings for incremental encoder sin/cos on SMC20

Parameter	Name	Value
p0400[0]	Enc type selection	2048, 1 Vpp, A/B R (2002)
p0404[0]	Encoder configuration effective	101010(hex)
p0404[0].0	Linear encoder	No
p0404[0].1	Absolute value encoder	No
p0404[0].2	Multiturn encoder	No
p0404[0].3	Track A/B square-wave	No
p0404[0].4	Track A/B sinusoidal	Yes
p0404[0].5	Track C/D	No
p0404[0].6	Hall sensor	No
p0404[0].8	EnDat encoder	No
p0404[0].9	SSI encoder	No
p0404[0].12	Equidistant zero mark	Yes
p0404[0].13	Irregular zero mark	No
p0404[0].14	Distance-coded zero mark	No
p0404[0].15	Commutation with zero mark	No
p0404[0].16	Acceleration	No
p0404[0].20	Voltage level 5 V	Yes
p0404[0].21	Voltage level 24 V	No
p0404[0].22	Remote sense (only SMC30)	No
p0404[0].23	Resolver excit.	Yes
p0405[0]	Square-wave signal encoder A/B track	0(hex)
p0407[0]	Linear encoder scale	0
p0408[0]	Rotary encoder pulse No.	2048
p0410[0]	Encoder inversion actual value	0(hex)
p0425[0]	Encoder, rotary zero mark distance	2048

4.9.19 SMC30 Sensor Module Cabinet-Mounted (option K50)

4.9.19.1 Description

The SMC30 Sensor Module is used for determining the actual motor speed. The signals emitted by the rotary pulse encoder are converted here and made available to the closed-loop controller via the DRIVE-CLiQ interface for evaluation purposes.

The following encoders can be connected to the SMC30 Sensor Module:

- TTL encoder
- HTL encoder
- SSI encoder
- KTY or PTC temperature sensor

Table 4- 45 Connectable encoders with supply voltage

Encoder type	X520 (D-Sub)	X521 (terminal)	X531 (terminal)	Open-circuit monitoring	Remote sense
HTL bipolar 24 V	Yes	Yes	Yes	Yes	No
HTL unipolar 24 V	Yes	Yes	Yes	No	No
TTL bipolar 24 V	Yes	Yes	Yes	Yes	No
TTL bipolar 5 V	Yes	Yes	Yes	Yes	To X520
TTL unipolar	No	No	No	No	No
SSI 24 V/5 V	Yes	Yes	Yes	No	No

Table 4- 46 Maximum signal cable lengths

Encoder type	Maximum signal cable length in m
TTL	100
HTL unipolar	100
HTL bipolar	300
SSI	100

Note

Because the physical transmission media is more robust, the bipolar connection should always be used for HTL encoders. The unipolar connection should only be used if the encoder type does not output push-pull signals.

Table 4- 47 Specification of measuring systems that can be connected

Parameter	Designation	Threshold ⁴⁾	Min.	Max.	Unit
High signal level (TTL bipolar at X520 or X521/X531) ¹⁾	U _{Hdiff}		2	5	V
Low signal level (TTL bipolar at X520 or X521/X531) ¹⁾	U _{Ldiff}		-5	-2	V
High signal level (HTL unipolar)	U _H ⁴⁾	High	17	V _{CC}	V
		Low	10	V _{CC}	V
Low signal level (HTL unipolar)	U _L ⁴⁾	High	0	7	V
		Low	0	2	V
High signal level (HTL bipolar) ²⁾	U _{Hdiff}		3	V _{CC}	V
Low signal level (HTL bipolar) ²⁾	U _{Ldiff}		-V _{CC}	-3	V
High signal level (SSI bipolar at X520 or X521/X531) ¹⁾	U _{Hdiff}		2	5	V
Low signal level (SSI bipolar at X520 or X521/X531) ¹⁾	U _{Ldiff}		-5	-2	V
Signal frequency	f _s		-	300	kHz
Edge clearance	t _{min}		100	-	ns
Zero pulse inactive time (before and after A=B=high)	t _{Lo}		500	(t _{ALo-BHi} - t _{Hi})/2 ³⁾	ns
Zero pulse active time (while A=B=high and beyond)	t _{Hi}		500	t _{ALo-BHi} - 2 x t _{Lo} ³⁾	ns

¹⁾ Other signal levels according to the RS 422 standard.

²⁾ The absolute level of the individual signals varies between 0 V and V_{CC} of the measuring system.

³⁾ t_{ALo-BHi} is not a specified value, but is the time between the falling edge of track A and the next but one rising edge of track B.

⁴⁾ The threshold can be set via p0405.04 (switching threshold); the factory setting is "Low".

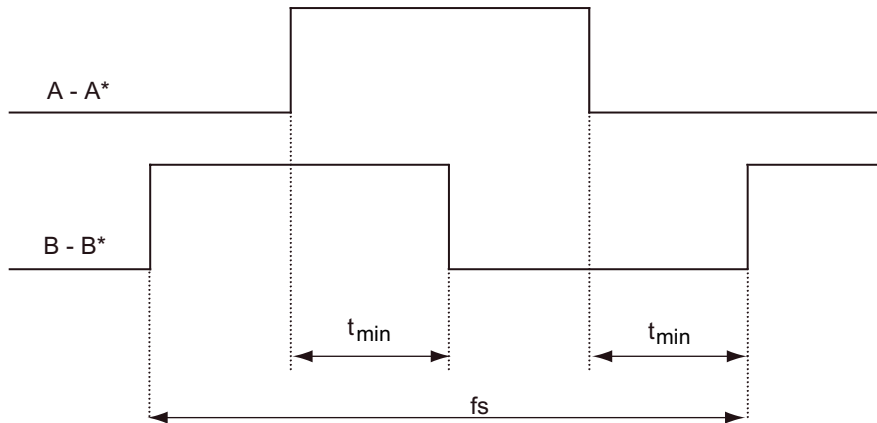


Figure 4-21 Signal characteristic of the A and B track between two edges: Time between two edges with pulse encoders

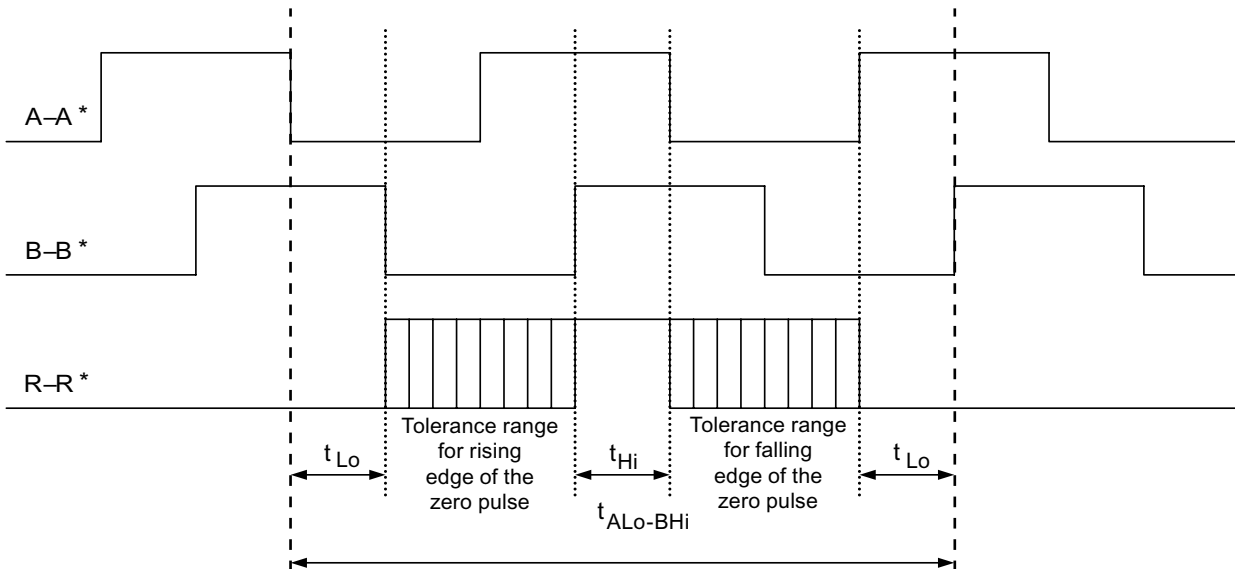


Figure 4-22 Position of the zero pulse to the track signals

For encoders with a 5 V supply at X521/X531, the cable length is dependent on the encoder current (this applies cable cross-sections of 0.5 mm²):

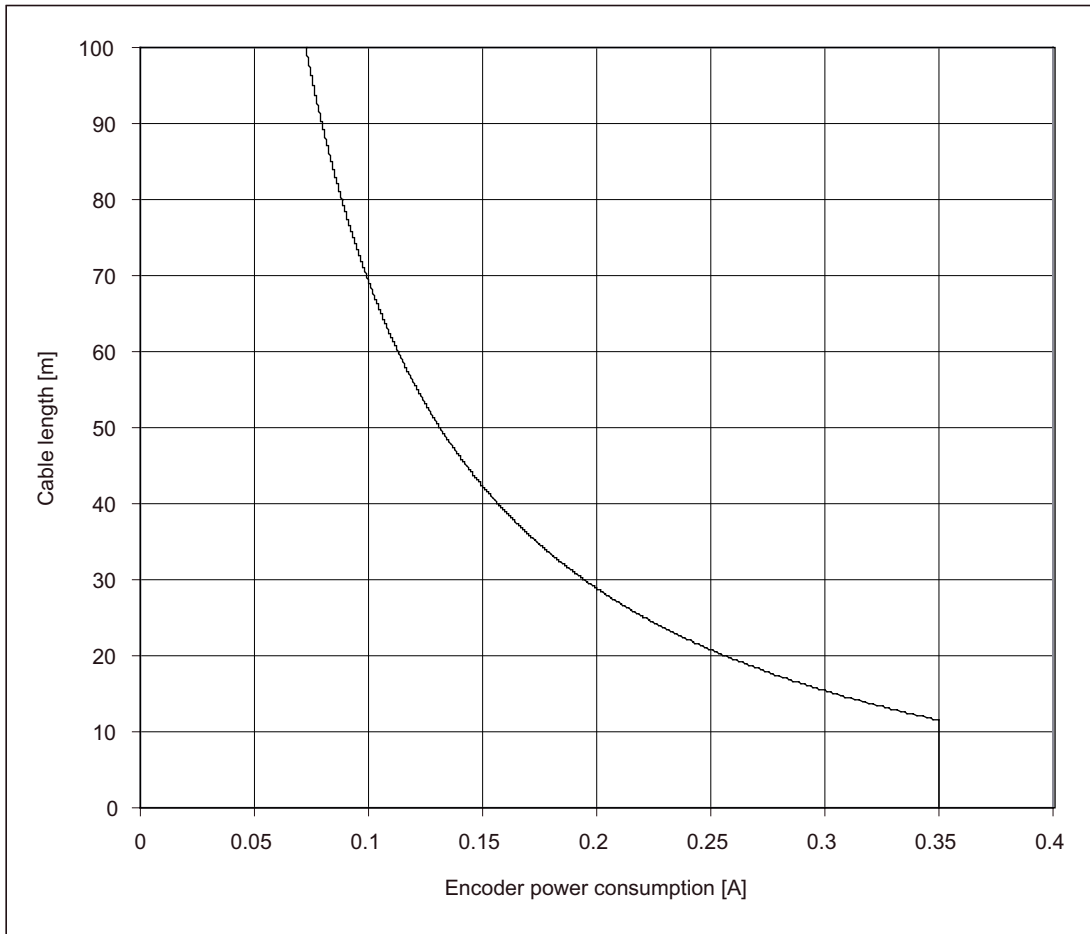


Figure 4-23 Signal cable length as a function of the sensor current consumption

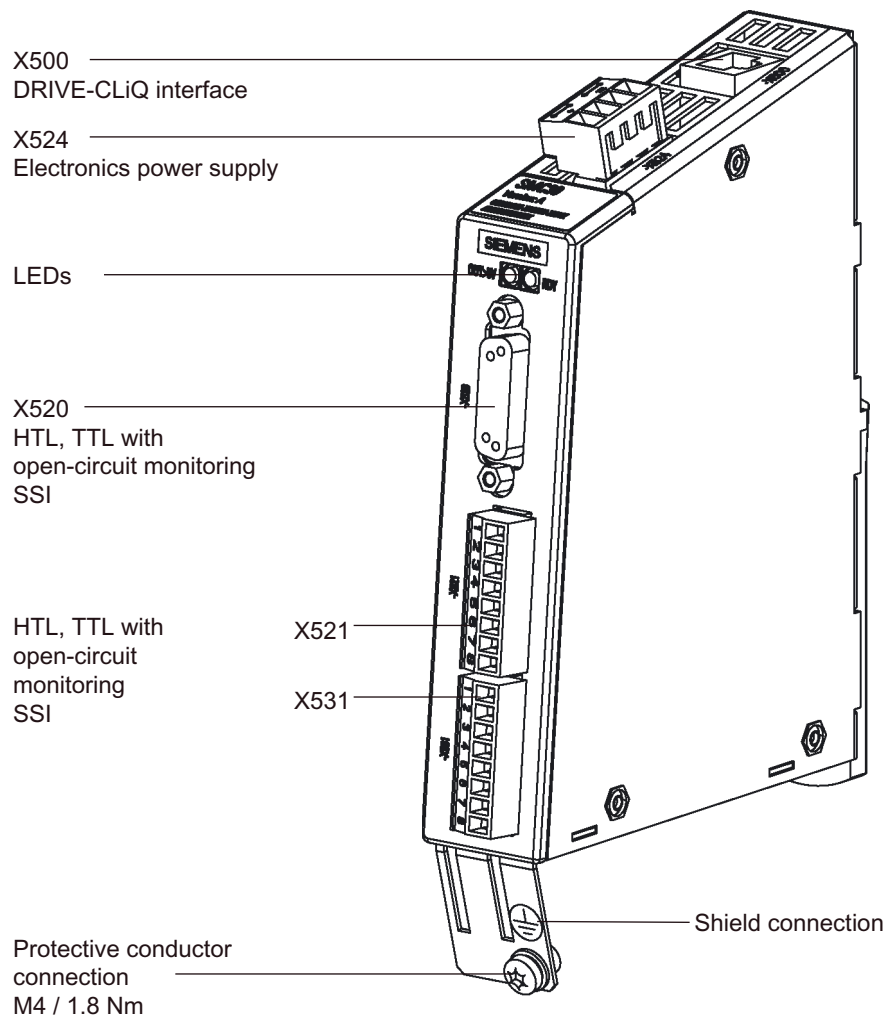
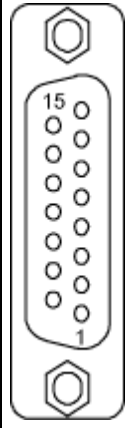


Figure 4-24 SMC30 Sensor Module

4.9.19.2 Connection

X520: Encoder connection 1 for HTL/TTL/SSI encoder with open-circuit monitoring

Table 4- 48 Encoder connection X520

	Pin	Signal name	Technical specifications
	1	+Temp	Temperature sensor connection KTY84-1C130/PTC
	2	SSI_CLK	SSI clock
	3	SSI_XCLK	Inverted SSI clock
	4	P_Encoder 5 V / 24 V	Encoder supply
	5	P_Encoder 5 V / 24 V	Encoder supply
	6	P_Sense	Sense input encoder power supply
	7	M_Encoder (M)	Ground for encoder power supply
	8	-Temp	Temperature sensor connection KTY84-1C130/PTC
	9	M_Sense	Ground sense input
	10	R	Reference signal R
	11	R*	Inverted reference signal R
	12	B*	Inverted incremental signal B
	13	B	Incremental signal B
	14	A*/data*	Inverted incremental signal A / inverted SSI data
	15	A/data	Incremental signal A / SSI data

Connector type: 15-pin socket

CAUTION

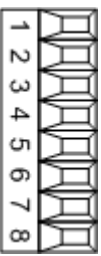
The encoder power supply can be parameterized to 5 V or 24 V. The encoder may be destroyed if you enter the wrong parameter.

NOTICE

The KTY temperature sensor must be connected with the correct polarity.

X521 / X531: Encoder connection 2 for HTL/TTL/SSI encoder with open-circuit monitoring

Table 4- 49 Encoder connection X521

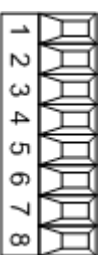
	Terminal	Signal name	Technical specifications
	1	A	Incremental signal A
	2	A*	Inverted incremental signal A
	3	B	Incremental signal B
	4	B*	Inverted incremental signal B
	5	R	Reference signal R
	6	R*	Inverted reference signal R
	7	CTRL	Control signal
	8	M	Ground via inductivity

Max. connectable cross-section: 1.5 mm²

Note

When unipolar HTL encoders are used, A*, B*, and R* on the terminal block must be jumpered with M_Encoder (X531).

Table 4- 50 Encoder connection X531

	Terminal	Signal name	Technical specifications
	1	P_Encoder 5 V / 24 V	Encoder supply
	2	M_Encoder	Ground for encoder power supply
	3	-Temp	Temperature sensor connection KTY84-1C130/PTC
	4	+Temp	
	5	clock	SSI clock
	6	clock*	Inverted SSI clock
	7	Data	SSI data
	8	data*	Inverted SSI data

Max. connectable cross-section: 1.5 mm²

Note

Note that when the encoder is connected via terminals, the cable shield must be applied to the module.

NOTICE
 The KTY temperature sensor must be connected with the correct polarity.

4.9.19.3 Connection examples

Connection example 1: HTL encoder, bipolar, without zero marker -> p0405 = 9 (hex)

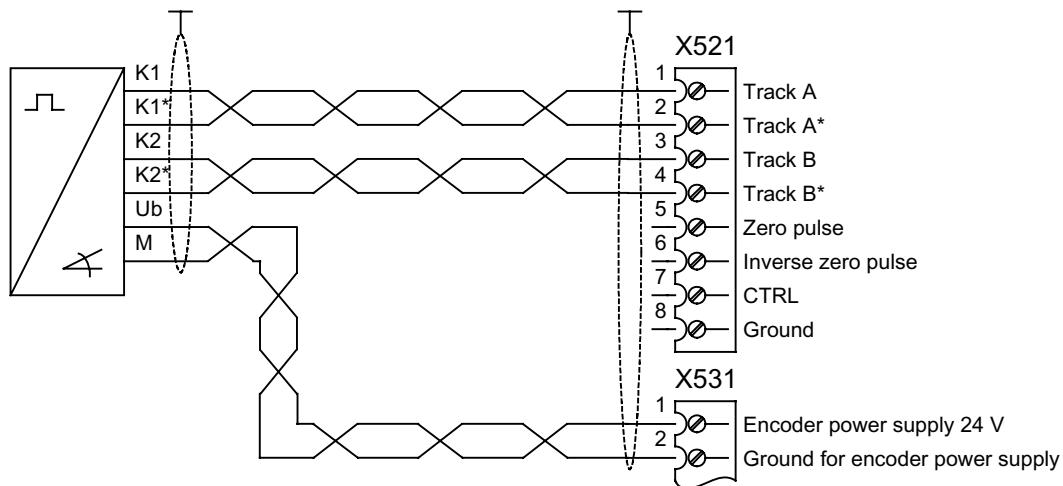


Figure 4-25 Connection example 1: HTL encoder, bipolar, without zero marker

Connection example 2: TTL encoder, unipolar, without zero marker -> p0405 = A (hex)

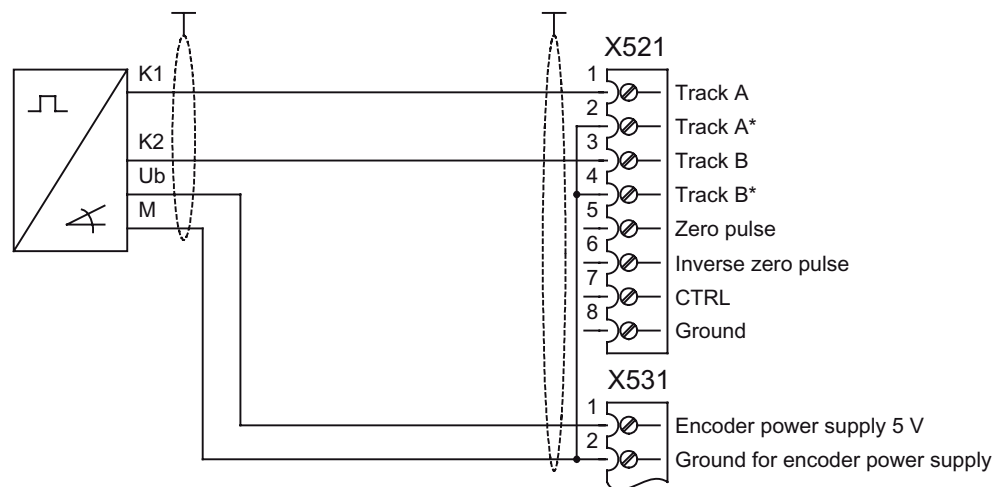


Figure 4-26 Connection example 2: TTL encoder, unipolar, without zero marker

4.9.20 Voltage Sensing Module for determining the actual motor speed and the phase angle (option K51)

Voltage recording module VSM10 is used to operate a permanent-field synchronous machine without encoder with the requirement for switching to a machine which is already running (capture function).

The terminals on the Voltage Sensing Module (-B51) are pre-assigned in the factory and must not be changed by the customer.

To commission the function, the permanent-field synchronous machine without encoder must be input and "Flying restart" activated with p1200.

4.9.21 Customer terminal block extension (option G61)

Description

A TM31 interface module (customer terminal block –A60) is already installed in standard. A second module (–A61) provides the following additional digital and analog inputs/outputs in the drive system:

- 8 digital inputs
- 4 bidirectional digital inputs/outputs
- 2 relay outputs with changeover contact
- 2 analog inputs
- 2 analog outputs
- 1 temperature sensor input (KTY84-130/PTC)

The second TM31 must be installed on the system side. Default settings are not provided.

4.9.22 Terminal module for activation of "Safe Torque Off" and "Safe STOP 1" (option K82)

Description

Option K82 (terminal module for activating "Safe Torque Off" and "Safe Stop 1") is used for isolated activation via a variable control-voltage range of the safety functions already present in the standard version, which can also be used without option K82.

Use the option K82 to activate the following safety integrated functions (terminology according to draft IEC 61800-5-2):

- Safe torque off (STO)
- Safe Stop 1 (SS1, time-controlled)

Note

The integrated safety functions, starting from the Safety Integrated (SI) input terminals of the SINAMICS components (Control Unit, Motor Module), satisfy the requirements in accordance with the equipment directive 98/37/EC, the EN 60204-1, DIN EN ISO 13849-1 category 3 (formerly EN954-1) as well as the requirements for Performance Level (PL) d and IEC 61508 SIL2.

In combination with option K82, the requirements specified in Machinery Directive 98/37/EC, as well as in EN 60204-1 and DIN EN ISO 13849-1 category 3 (formerly EN 954-1) are satisfied for Performance Level (PL) d and IEC 61508 SIL2.

Note

Detailed and comprehensive instructions and information for the Safety Integrated functions can be found in the accompanying operating instructions, which are available as additional documentation on the enclosed customer CD.

4.9.23 NAMUR terminal block (option B00)

Description

The terminal block is designed in accordance with the requirements and guidelines defined by the standards association for measurement and control systems in the chemical industry (NAMUR – recommendation NE37), that is, certain device functions are assigned to fixed terminals. The inputs and outputs assigned to the terminals fulfill PELV ("protective extra-low voltage and protective separation") requirements.

The terminal block only contains the necessary functions. Unlike the NAMUR recommendation, optional terminals are not available.

The 24 V DC is supplied on the line side via terminals –A1-X2:1-3 (protected with 1 A within the converter). You must ensure that the PELV safety requirements (protective extra-low voltage with protective separation) are fulfilled.

To monitor the temperature of explosion-proof motors, option B00 features a PTC thermistor release mechanism with PTB approval. Shutdown if limit value is exceeded. The associated PTC sensor is connected to terminal –A1-X3:90, 91.

The terminal block is divided into three sections:

- -X1; -X2: for the power connections
- -A1-X2: for signal cables, which must fulfill PELV requirements with electrical separation.
- -A1-X3: for connecting the motor PTC thermistor detector

Connection

Table 4- 51 Terminal block -A1-X2 – 24 V supply voltage connection

Terminal	Designation	Default	Comments
1	M	Reference conductor	
2	P24 V	24 V DC supply	Protected internally with fuse (1 A)
3	P24 V	24 V DC outgoing circuit	

Max. connectable cross-section: 2.5 mm²

Table 4- 52 Terminal block -A1-X2 – connection NAMUR control terminal block

Terminal	Designation	Default	Comments
10	DI	ON/OFF (dynamic)/ ON/OFF (static)	Effective operation can be coded by a wire jumper on terminal –A1-X400:9;10 (factory setting: jumper inserted): jumper inserted: ON/OFF (dynamic)/ jumper removed: ON/OFF (static)
11	DI	OFF (dynamic)	
12	DI	Faster	Motorized potentiometer
13	DI	Slower	Motorized potentiometer
14	DI	RESET	Acknowledge error
15	DI	Interlock	OFF2
16	DI	Counterclockwise	"0" signal: CW phase sequence "1" signal: CCW phase sequence
17	DI	Power Disconnection	EMERGENCY OFF circuit
18			"0" signal: Power disconnection "1" signal: No power disconnection
30	DO (COM)	Ready for operation	Relay output (NO contact)
31	DO (NO)		
32	DO (COM)	Motor turning	Relay output (NO contact)
33	DO (NO)		
34	DO (NO)	Fault	Relay output (two-way contact)
35	DO (COM)		
36	DO (NC)		
50/51	AI 0/4-20 mA		
60/61	AO 0/4-20 mA	Motor frequency	Default: 4 - 20 mA (defaulted with motor frequency, can be reparameterized for other variables)
62/63	AO 0/4-20 mA	Motor current	Default: 4 - 20 mA (defaulted with motor current, can be reparameterized for other variables)

Max. connectable cross-section: 2.5 mm²

Table 4- 53 Terminal block -A1-X3 – connection for the motor PTC thermistor sensor

Terminal	Designation	Default	Comments
90/91	AI	Connection for a PTC thermistor	Shutdown if limit value is exceeded.

Max. connectable cross-section: 2.5 mm²

Adapting the analog inputs and outputs

If the setting ranges of the analog inputs and outputs are to be changed, the associated interface converters (-T411 / -T412 / -T413) must be set. The corresponding interface converter must be removed for this purpose and the rotary switch on the side ("S1") turned to the corresponding position.

Table 4- 54 Terminal block -A1-X2 – Adaptation of analog inputs and outputs

Terminal	Designation	Item code of interface converter	Settings on rotary switch S1
50/51	AI	T411	2: 0 - 20 mA 4: 4 - 20 mA (preassignment)
60/61	AO	T412	1: 0 - 20 mA 2: 4 - 20 mA (preassignment)
62/63	AO	T413	1: 0 - 20 mA 2: 4 - 20 mA (preassignment)

4.9.24 Electrically separate 24 V DC power supply for NAMUR (option B02)

Description

If the customer cannot provide a separate 24 V DC supply (PELV), this option enables a second power supply to be installed to provide the PELV (terminal assignment as option B00, 24 V infeed at terminal -A1-X1:1,2,3 no longer needed).

4.9.25 Outgoing section for external auxiliary equipment for NAMUR (option B03)

Description

If power is to be supplied to a motor fan on site, option B03 provides an uncontrolled fuse-protected (10 A) outgoing section. As soon as the supply voltage is present at the converter input, it is also present at these terminals. The voltage corresponds to the converter input voltage. You must take this into account when configuring the separately driven fan.

Connection

Table 4- 55 Terminal block -A1-X1 – uncontrolled power outlet (10 A) for supplying a separately driven motor fan

Terminal	Default	Comments
1, 2, 3, PE	Outgoing section for separately driven motor fan	$U = U_{line}$

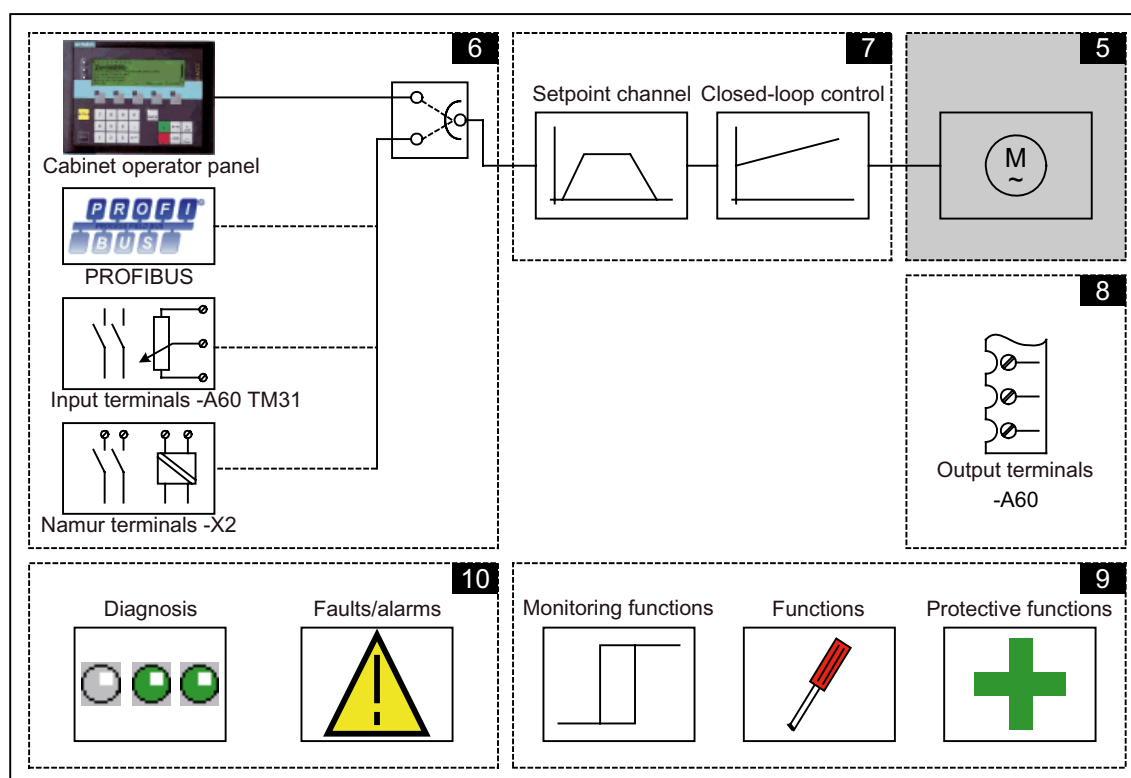
Max. connectable cross-section: 2.5 mm²

Commissioning

5.1 Chapter content

This chapter provides information on the following:

- An overview of the operator panel functions
- Initial commissioning of the cabinet (initialization)
 - Entering the motor data (drive commissioning)
 - Entering the most important parameters (basic commissioning), concluding with motor identification
- Data backup
- Parameter reset to factory settings



Important information prior to commissioning

The cabinet unit offers a varying number of internal signal interconnections depending on the delivery condition and the options installed. For the converter control to be able to process the signals correctly, several software settings must be made.

During initial power-up of the CU320 Control Unit and during first commissioning, parameter macros are executed and the necessary settings made.

The settings are documented in the Appendix.

After initial power-up, first commissioning, and also following a "Parameter reset to factory settings", individual parameter values deviate from the factory settings stated in the List Manual.

5.2 STARTER commissioning tool

Description

You can use the STARTER commissioning tool to configure and commission SINAMICS drives and drive systems. The drive can be configured using the STARTER drive configuration wizard.

Note

This chapter shows you how to carry out commissioning using STARTER. STARTER features a comprehensive online help function, which provides detailed explanations of all the processes and available system settings.

For this reason, this chapter only describes the individual commissioning steps.

Prerequisites for installing STARTER

Hardware requirements:

- PG or PC
- Pentium II 400 MHz (Windows 2000)
- Pentium III 500 MHz (Windows XP Professional)
- 512 MB main memory (1 GB recommended)
- 1024 x 768 pixel screen resolution

Software requirements for using STARTER without existing STEP7 installation:

- Microsoft Windows 2000 SP3, SP4
- Microsoft Windows Server 2003 SP1
- Microsoft Windows XP Professional SP1, SP2
- Internet Explorer V5.0.1 or higher
- Acrobat Reader V5.0 or higher is required to open the function diagrams in the online help.

Note

If STARTER is used in combination with other STEP7 components, the prerequisites for the S7 components shall apply.

5.2.1 Installing STARTER

STARTER is installed using the "setup" file on the CD supplied. When you double-click the "Setup" file, the installation Wizard guides you through the process of installing STARTER.

5.2.2 The STARTER user interface

STARTER features four operating areas:

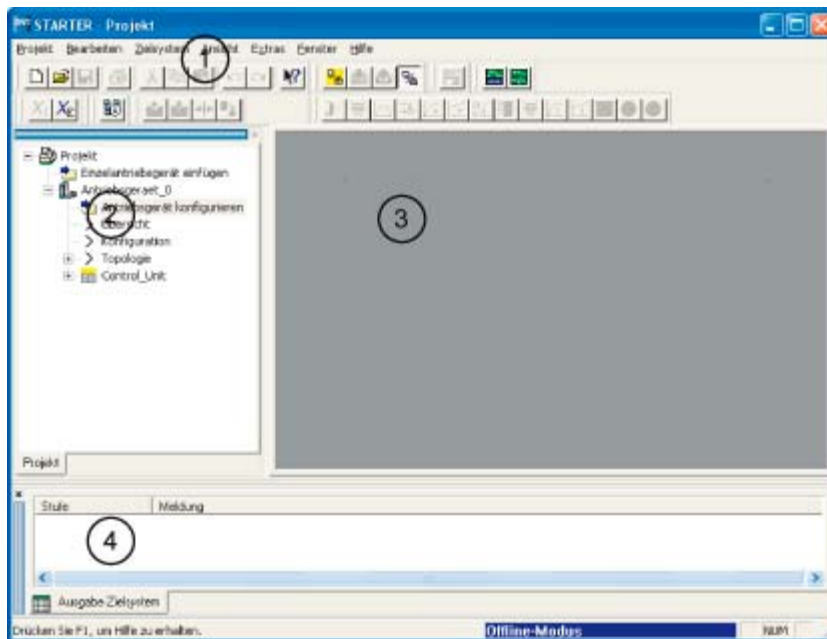


Figure 5-1 STARTER operating areas

Operating area	Explanation
1: Toolbars	In this area, you can access frequently used functions via the icons.
2: Project navigator	The elements and projects available in the project are displayed here.
3: Working area	In this area, you can change the settings for the drive units.
4: Detail view	Detailed information about faults and alarms, for example, is displayed this area.

5.3 Procedure for commissioning via STARTER

Basic procedure using STARTER

STARTER uses a sequence of dialog screens for entering the required drive unit data.

NOTICE
<p>These dialog screens contain default settings, which you may have to change according to your application and configuration.</p> <p>This is intentional because By taking time to consider what configuration data you enter, you can prevent inconsistencies between the project data and drive unit data (identifiable in online mode).</p>

5.3.1 Creating a project

Click the STARTER icon on your desktop or choose the following menu path in the Windows start menu to call up STARTER: Start > Simatic > STEP 7 > STARTER.

The first time you run the software, the main screen (shown below) appears with the following windows:

- STARTER Getting Started Drive Commissioning
- STARTER Project Wizard

The commissioning steps are listed below in numerical order.

Accessing the STARTER project wizard

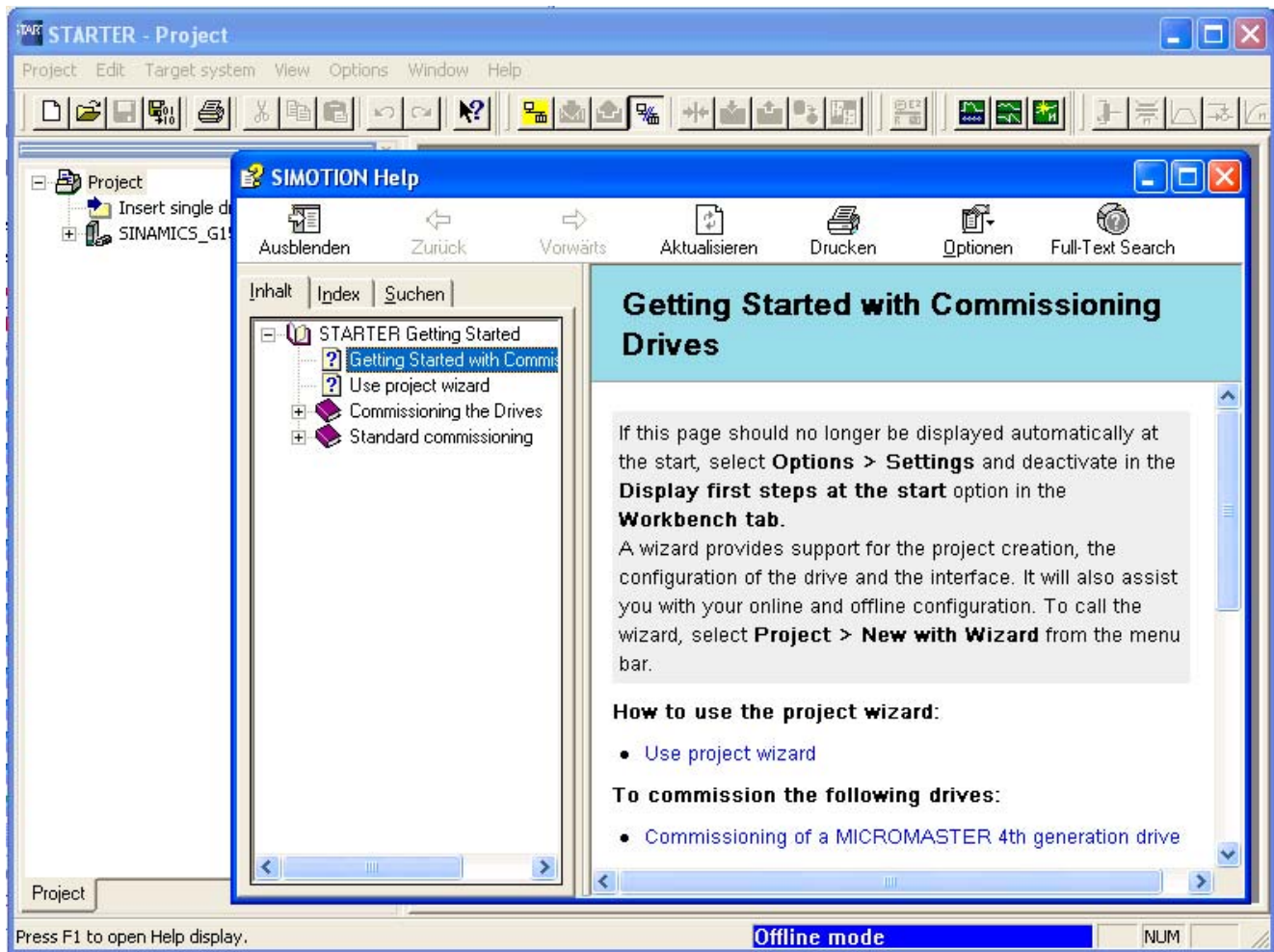


Figure 5-2 Main screen of the STARTER parameterization and commissioning tool

⇒ Close the "STARTER Getting Started Drive Commissioning" screen by choosing **HTML Help > Close**.

Note

When you deactivate the **Display wizard during start** checkbox, the project wizard is no longer displayed the next time you start STARTER.

You can call up the project wizard by choosing **Project > New with Wizard**.

To deactivate the online help for **Getting Started**, follow the instructions provided in Help.

You can call up the online help at any time by choosing **Help > Getting Started**.

STARTER features a detailed online help function.

The STARTER project wizard

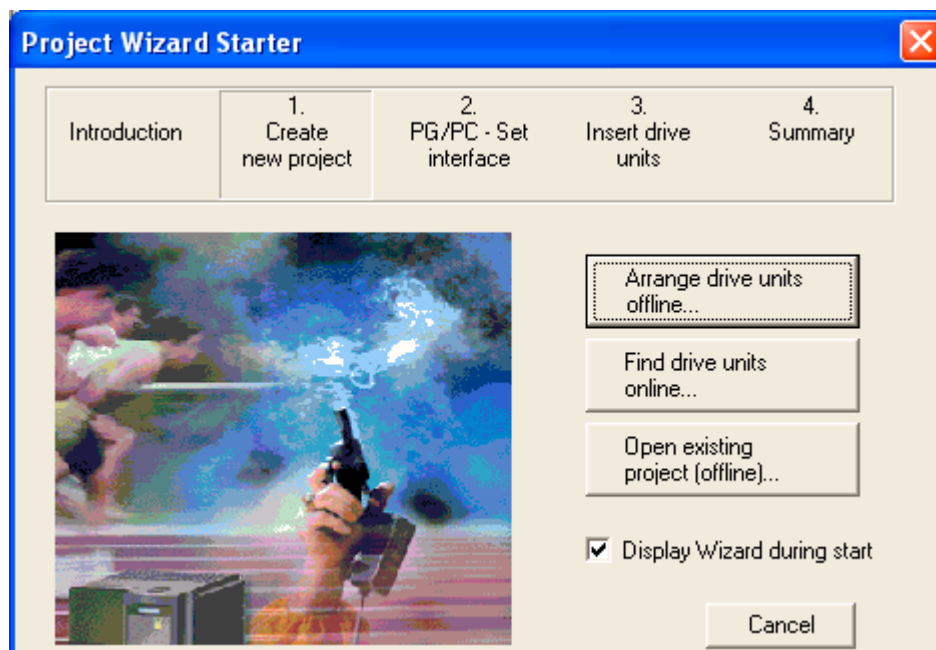


Figure 5-3 STARTER project wizard

⇒ Click **Arrange drive units offline...** in the STARTER project wizard.

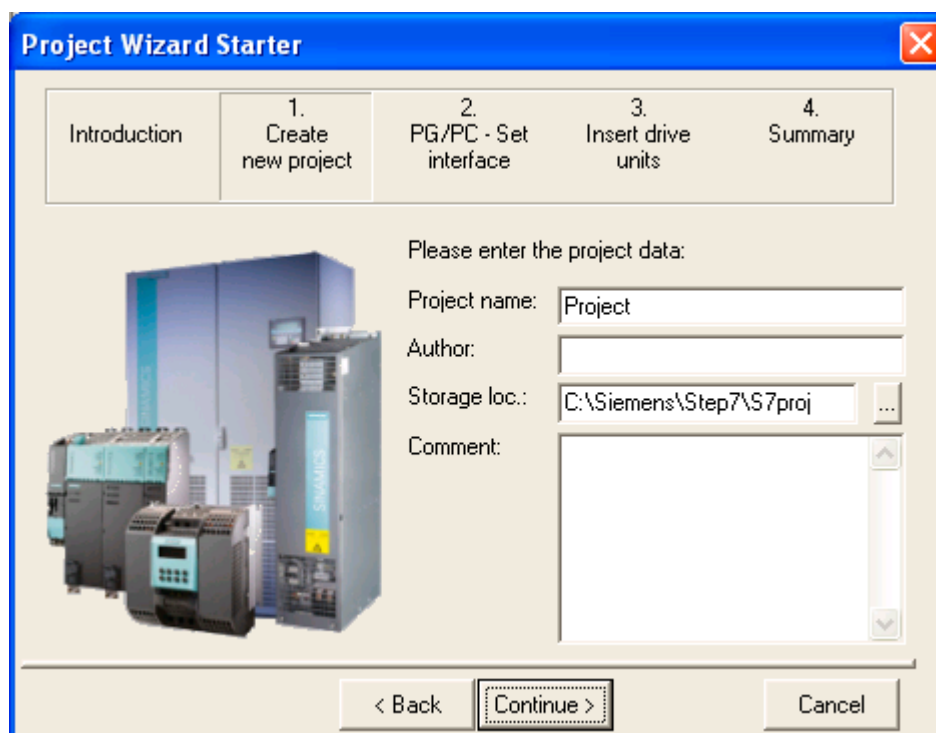


Figure 5-4 Create new project

⇒ Enter a **project name** and, if necessary, the **author**, **memory location** and a **comment**.

⇒ Click **Continue >** to set up the PG/PC interface.

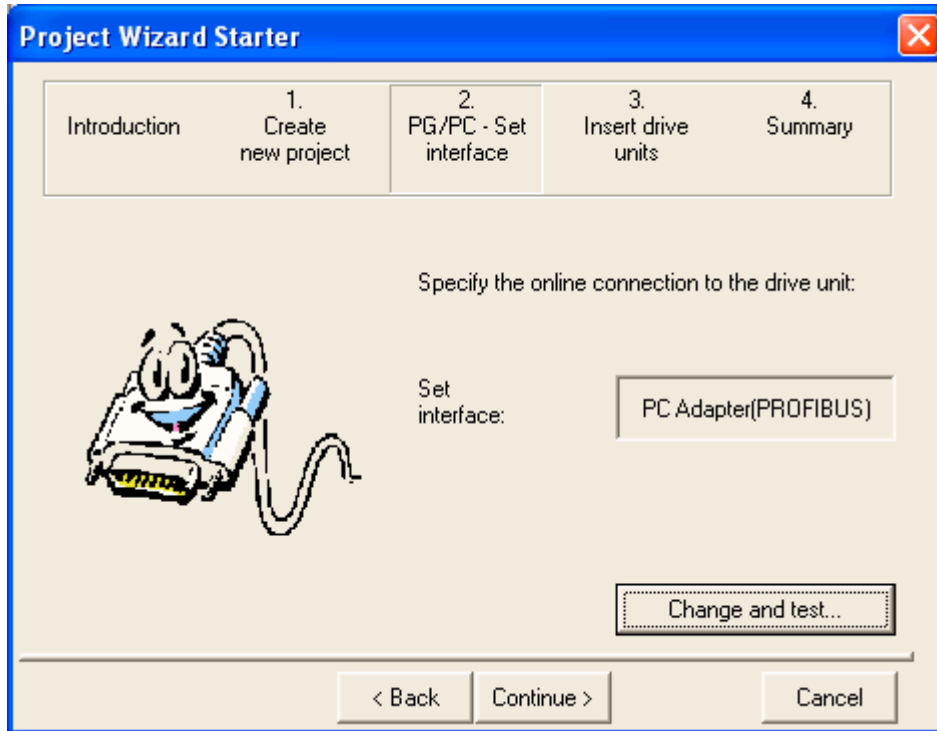


Figure 5-5 Set up interface

⇒ Click **Change and test...** and set up the interface in accordance with your device configuration.

The **Properties...**, **Copy...** and **Select...** pushbuttons are now active.

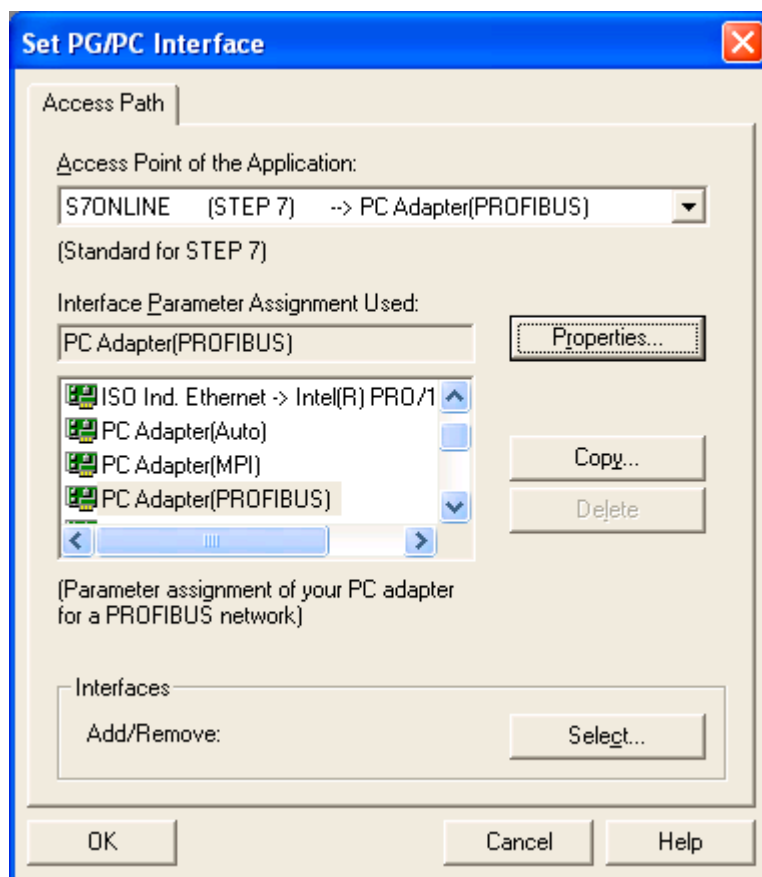


Figure 5-6 Setting the interface

Note

To parameterize the interface, you must install the appropriate interface card (e.g.: PC Adapter (PROFIBUS))

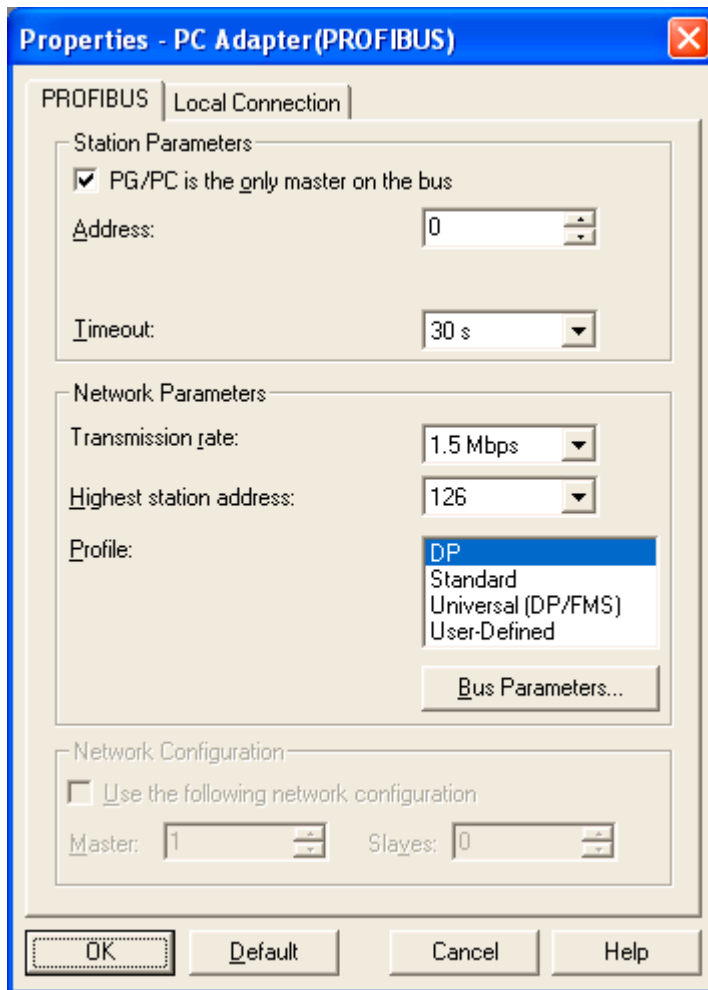


Figure 5-7 Setting the interface - properties

NOTICE

You must activate **PG/PC is the only master on bus** if no other master (PC, S7, etc.) is available on the bus.

Note

Projects can be created and PROFIBUS addresses for the drive objects assigned even if a PROFIBUS interface has not been installed on the PC.

To prevent bus addresses from being assigned more than once, only the bus addresses available in the project are proposed.

⇒ Once you have done this, click **OK** to confirm the settings and return to the project wizard.

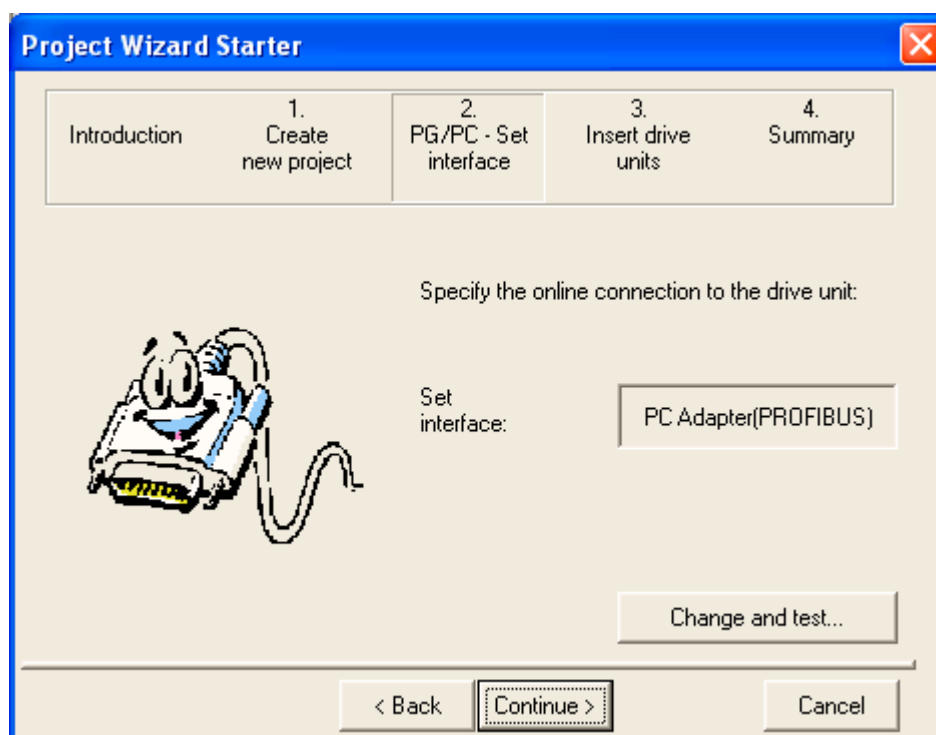


Figure 5-8 Setting the interface

⇒ Click **Continue >** to set up a drive unit in the project wizard.

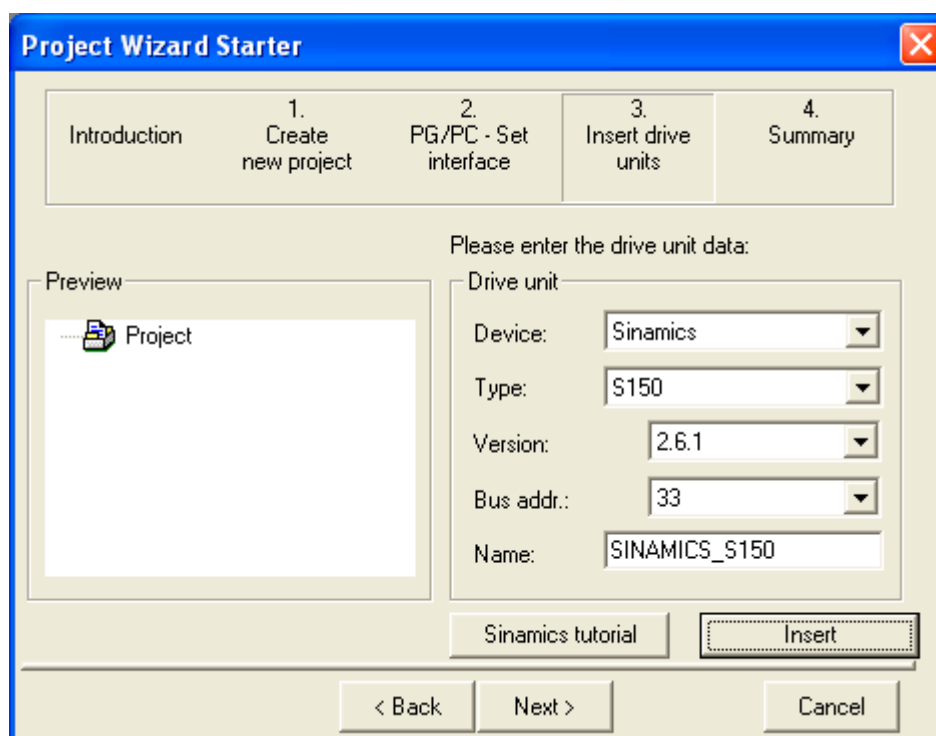


Figure 5-9 Inserting the drive unit

⇒ Choose the following data from the list fields:

Device: Sinamics

Type: S150

Version: 2.6x

Bus address: the corresponding bus address for the cabinet unit.

The entry in field **Name:** field is user defined.

⇒ Click **Insert**

The selected drive unit is displayed in a preview window in the project wizard.

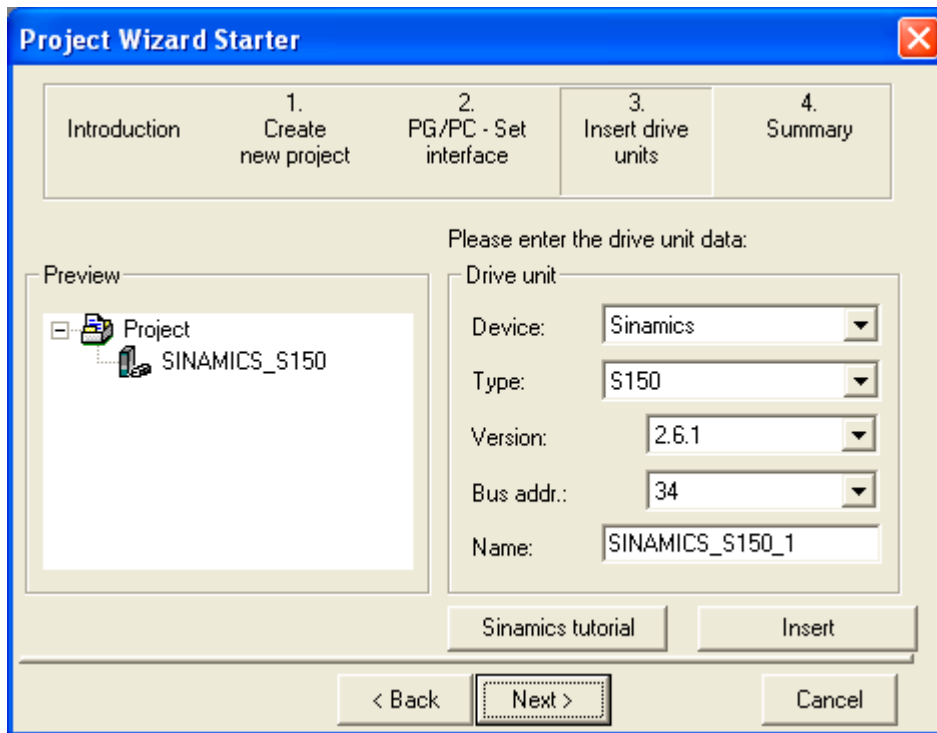


Figure 5-10 Inserting the drive unit

⇒ Click **Continue >**

A project summary is displayed.

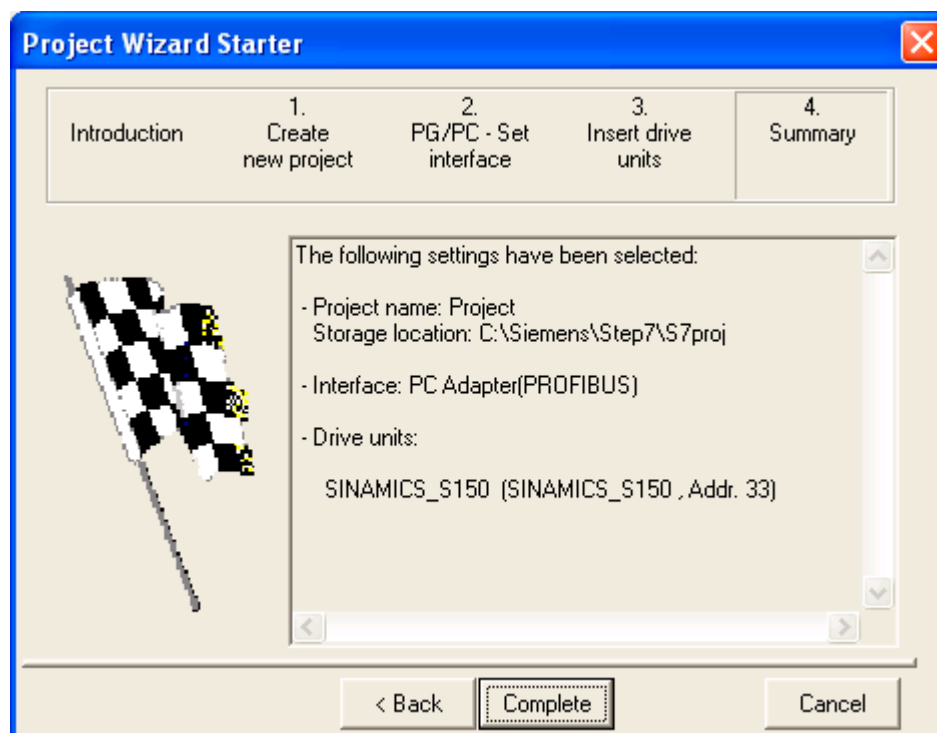


Figure 5-11 Summary

⇒ Click **Complete** to finish creating a new drive unit project.

5.3.2 Configuring the drive unit

In the project navigator, open the component that contains your drive unit.

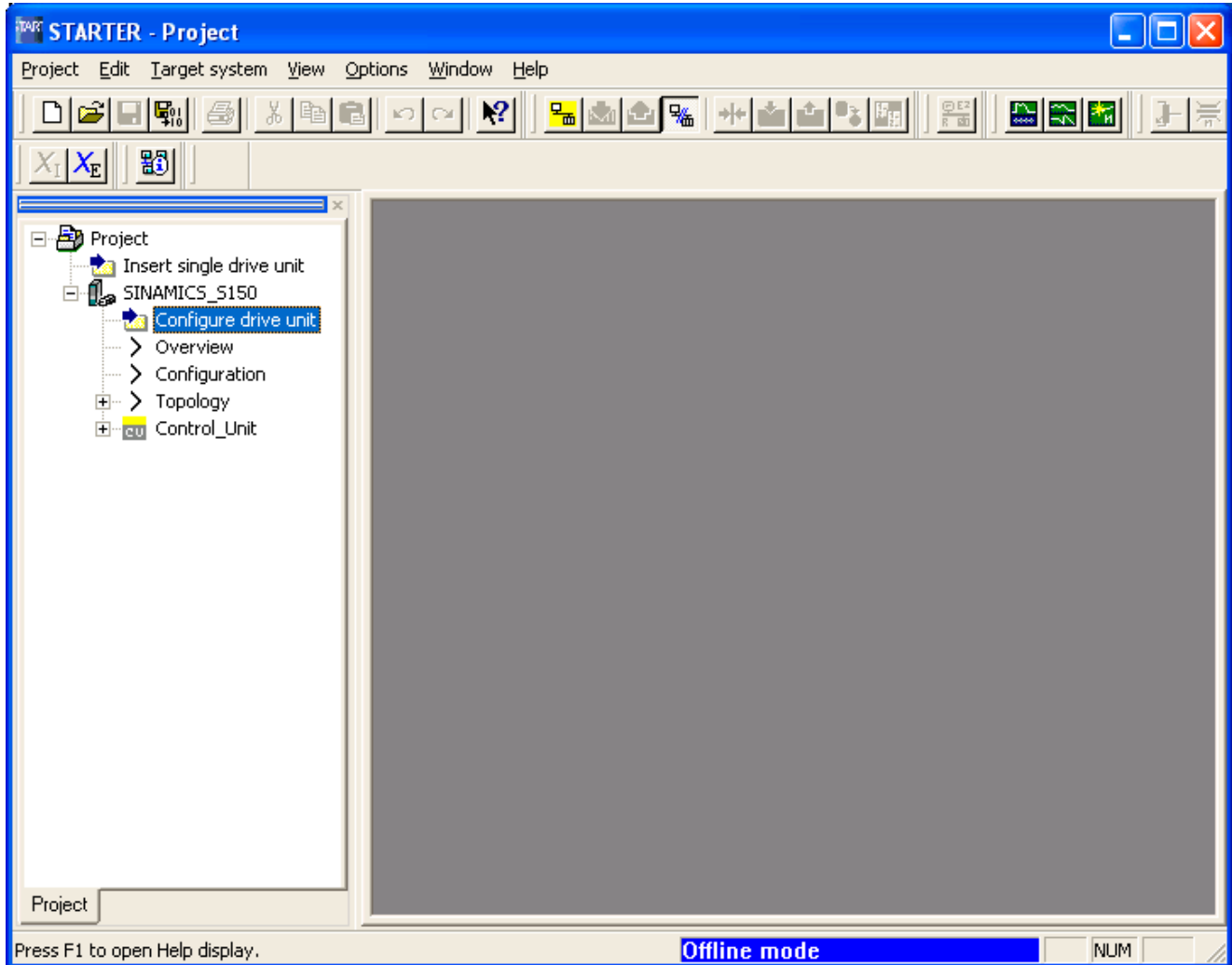


Figure 5-12 Project navigator – Configure drive unit

⇒ In the project navigator, click the plus sign next to the drive unit that you want to configure. The plus sign becomes a minus sign and the drive unit configuration options are displayed as a tree below the drive unit.

⇒ Double-click **Configure the drive unit**.

Configuring the drive unit

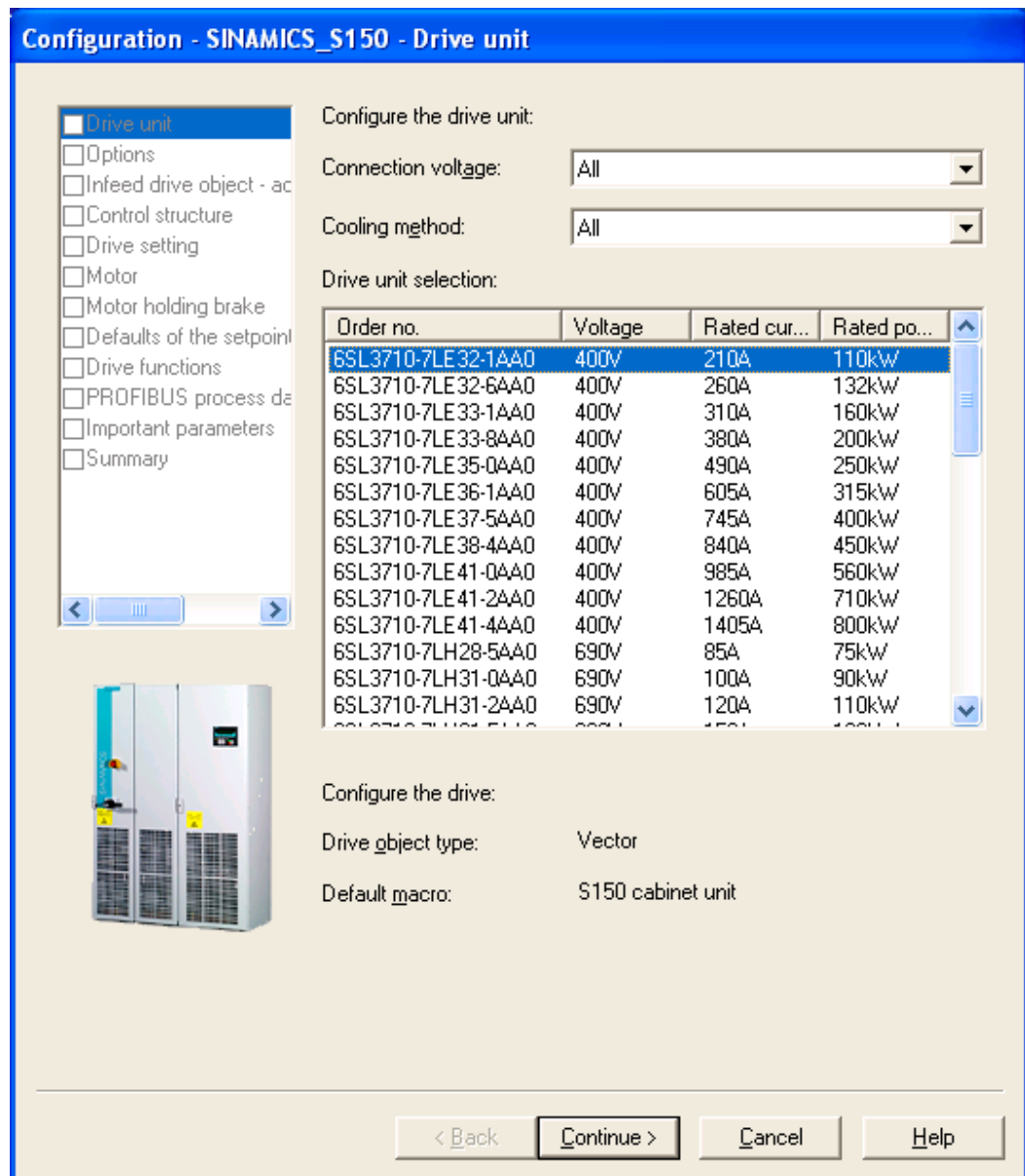


Figure 5-13 Configuring the drive unit

⇒ Under **Connection voltage**, choose the correct voltage. Under **Cooling type**: choose the correct cooling type for your drive unit.

Note

In this step, you make a preliminary selection of the cabinet units. You do not define the line voltage yet.

⇒ A list is now displayed under **Drive unit selection**:. Choose the corresponding drive unit according to type (order no.) (see type plate).

⇒ Click **Continue >**

Choosing the options

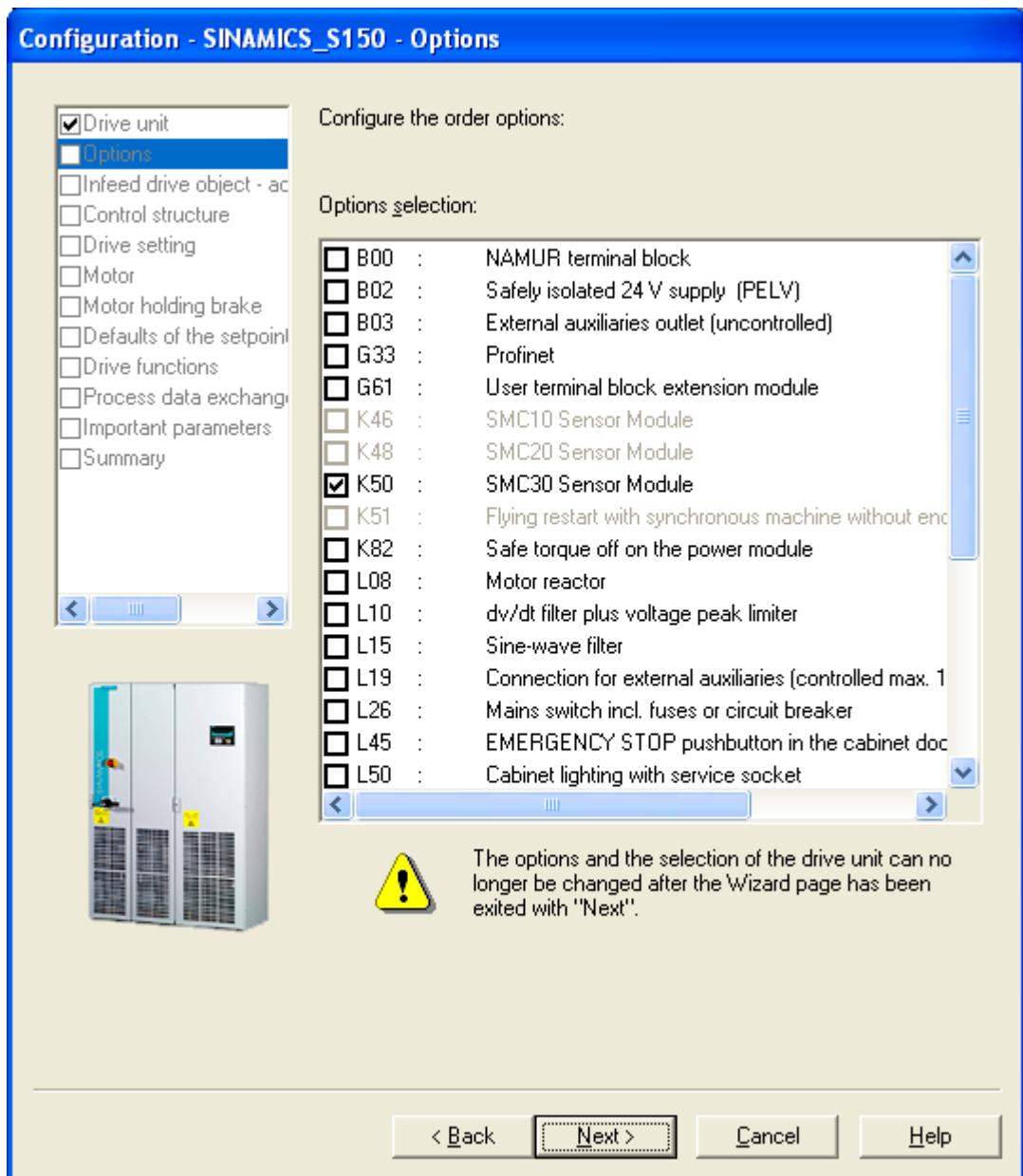


Figure 5-14 Choosing the options

⇒ From the combination box **Options selection**: select the options belonging to your drive unit by clicking on the corresponding check box (see type plate).

CAUTION

If a sine-wave filter (option L15) is connected, it must be activated when the options are selected to prevent the filter from being destroyed.

Note

Check your options carefully against the options specified on the type plate.

Since the wizard establishes internal interconnections on the basis of the options selected, you cannot change the selected options by clicking **< Back** .

If you make an incorrect entry, delete the entire drive unit from the project navigator and create a new one.

⇒ Check your options carefully and then click **Continue >**

Configure the infeed

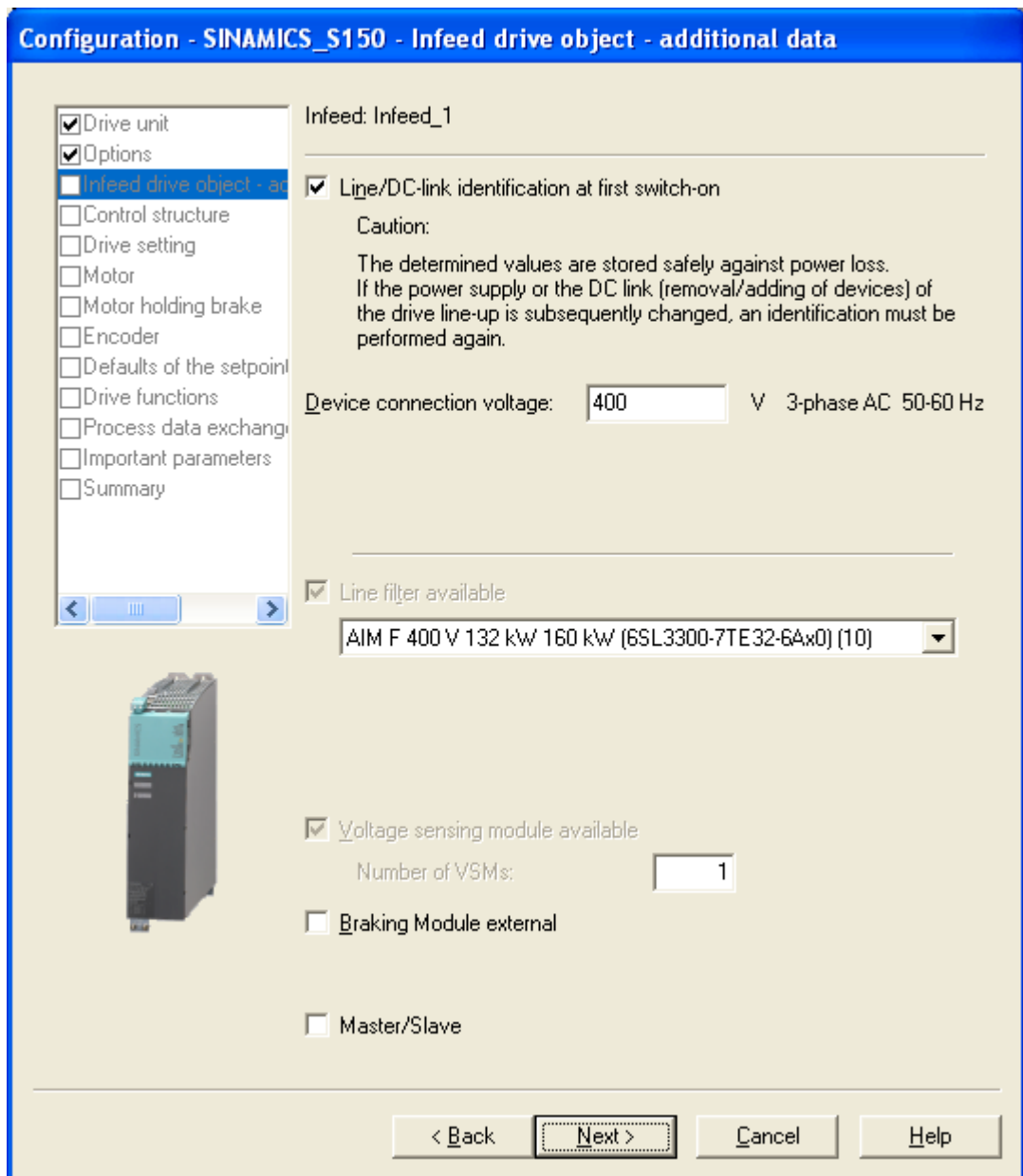


Figure 5-15 Configure the infeed

⇒ Choose whether the line and DC link identification function is to be activated during initial start-up.

(Recommendation: "Activate identification" = "Yes")

⇒ Specify the **Device connection voltage**.

⇒ Click **Continue >**

Selecting the control structure

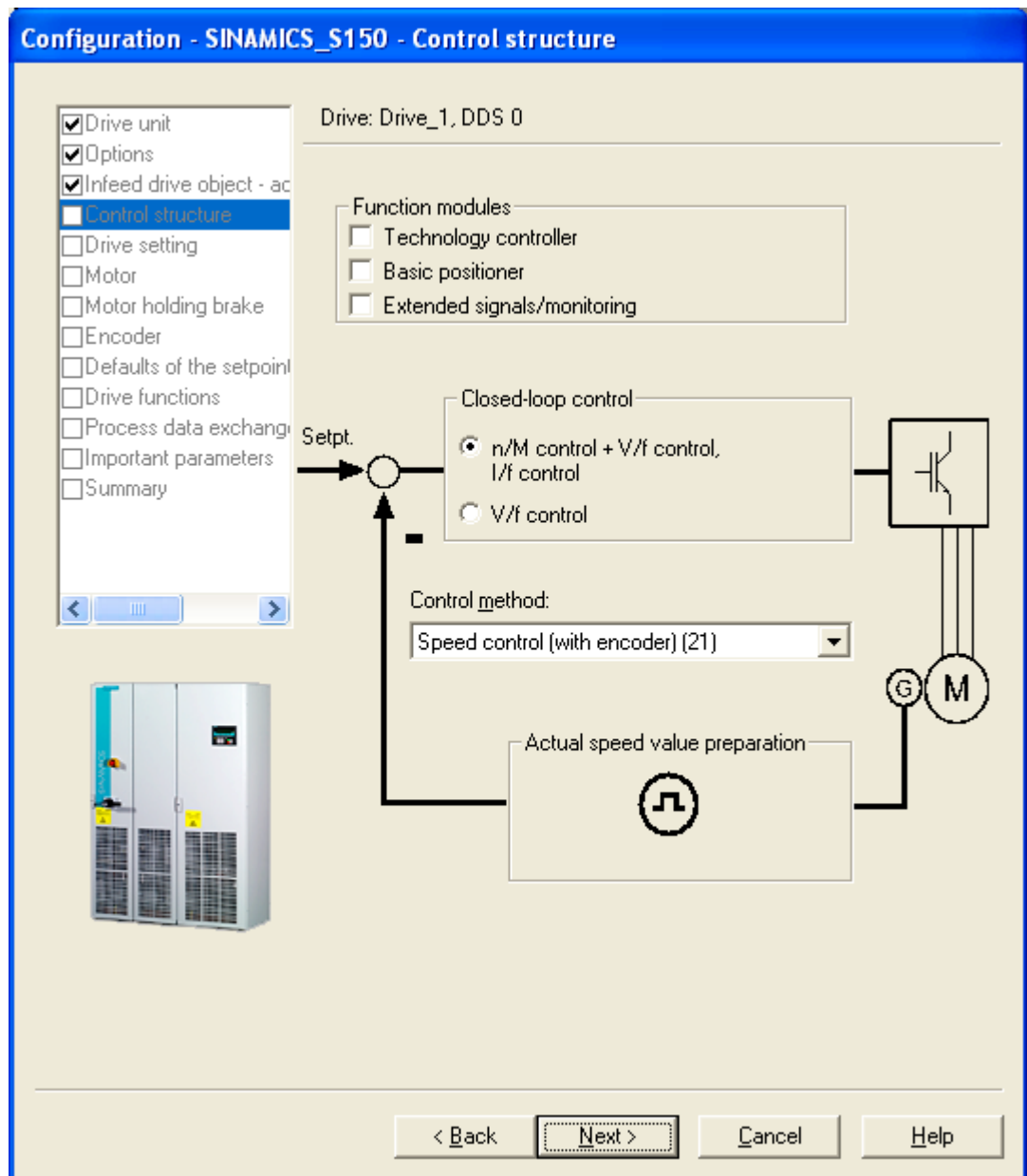


Figure 5-16 Selecting the control structure

⇒ Select the required data:

- **Function modules:**
 - Technology controller
 - Basic positioner
 - Extended messages/monitoring

- **Control method:**
choose one of the following open-loop/closed-loop control types:
 - Torque control (without encoder)
 - Torque control (with encoder)
 - Speed control (without encoder)
 - Speed control (with encoder)
 - I/f control with fixed current
 - V/f control for drive requiring a precise frequency (e.g. textiles)
 - V/f control for drive requiring a precise frequency with FCC
 - V/f control with linear characteristic
 - V/f control with linear characteristic and FCC
 - V/f control with parabolic characteristic
 - V/f control with parameterizable characteristic
 - V/f control with independent voltage setpoint

⇒ Click **Continue** >

Configuring the drive unit properties

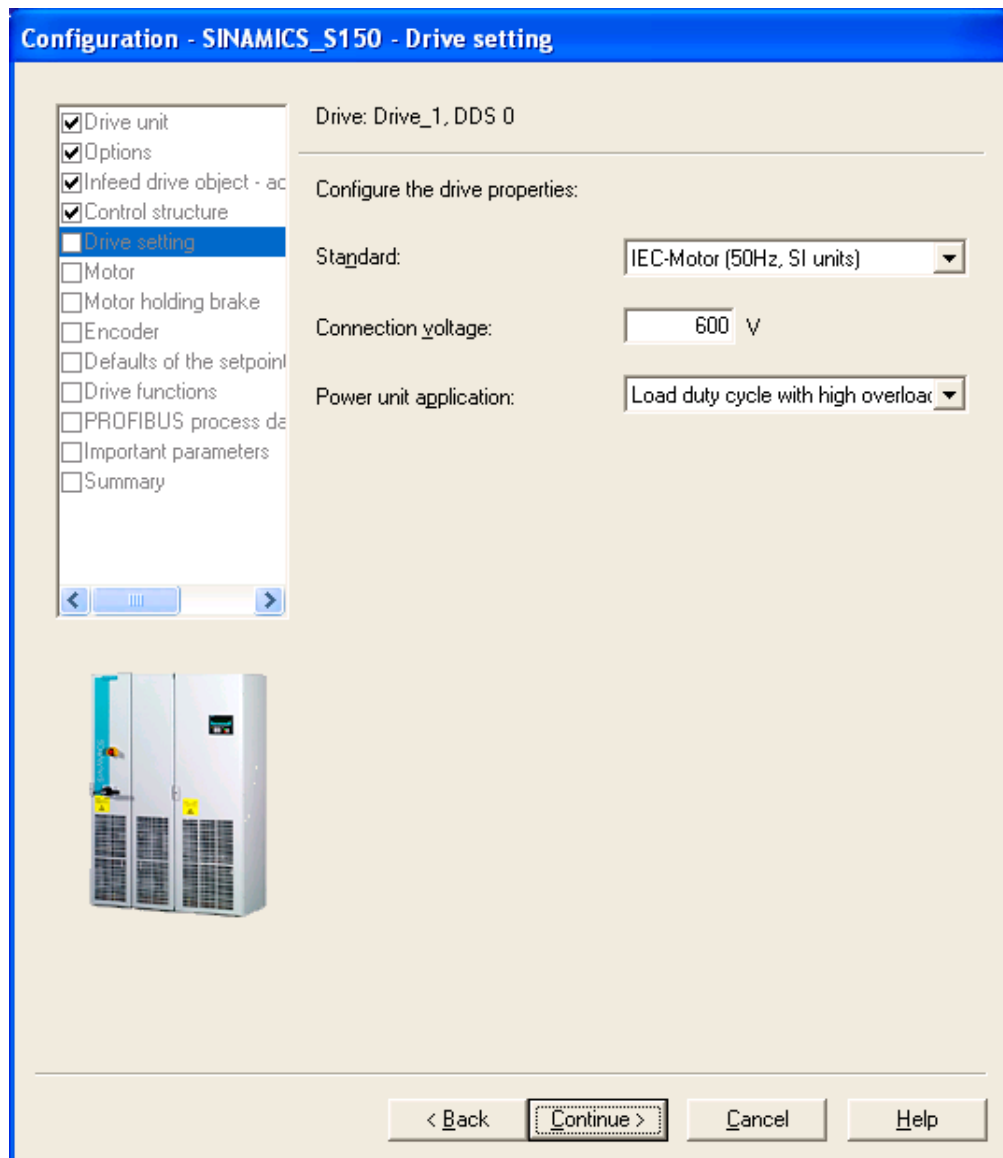


Figure 5-17 Configuring the drive unit properties

⇒ Under **Standard**:, choose the appropriate standard for your motor, whereby the following is defined:

- IEC motor (50 Hz, SI unit): Line frequency 50 Hz, motor data in kW
- NEMA motor (60 Hz, US unit): Line frequency 60 Hz, motor data in hp

⇒ Under **Connection voltage**: the DC link voltage of the cabinet unit is specified (this should not be changed).

⇒ Under **Power unit application**: choose the appropriate application for your drive unit:

- Load duty cycle with high overload condition for vector drives (factory setting)
- Load duty cycle with slight overload condition for vector drives

⇒ Click **Continue >**

Configuring the motor – Selecting the motor type

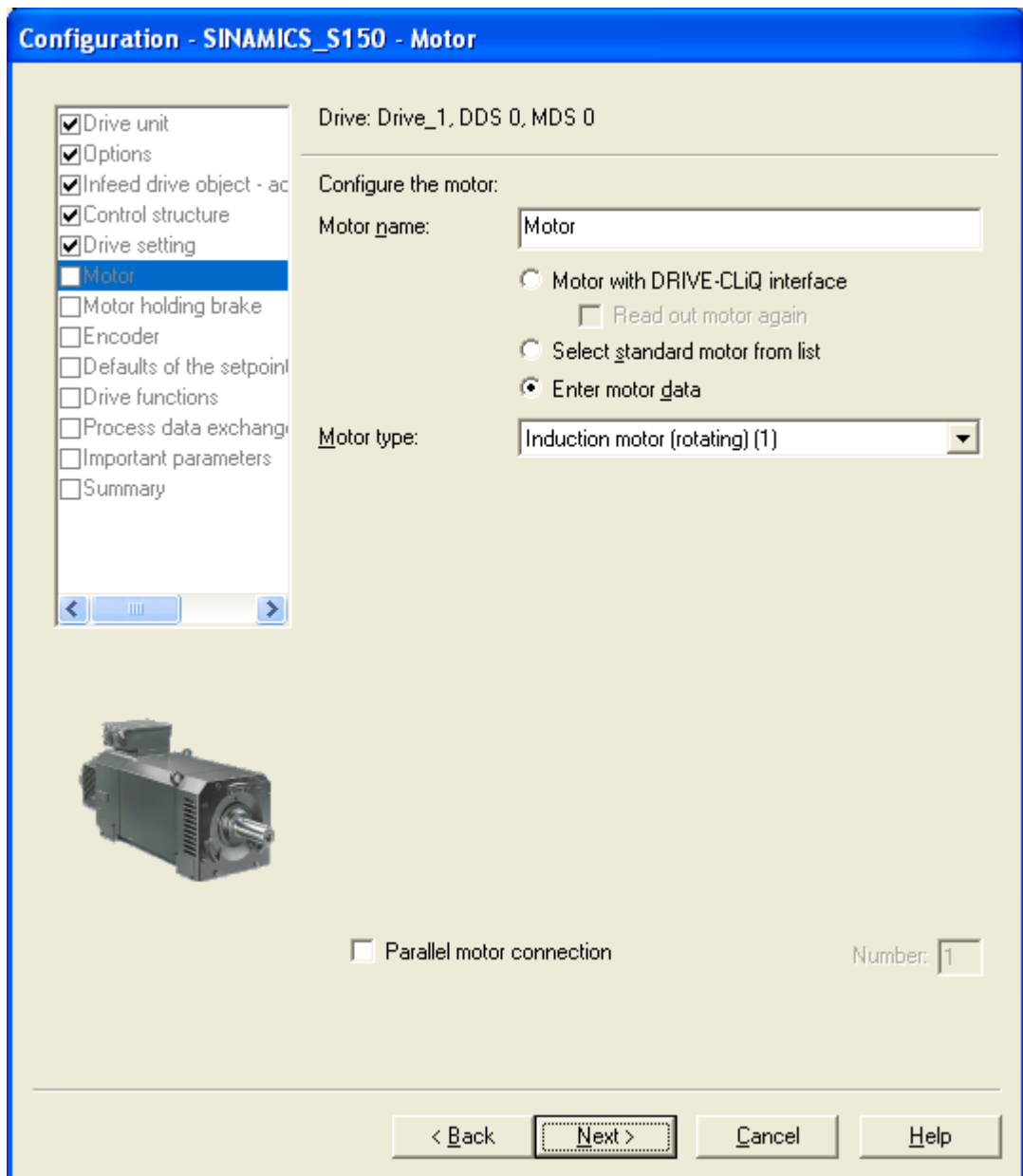


Figure 5-18 Configuring the motor – Selecting the motor type

⇒ In the **Name** field, enter a name of your choice for the motor.

⇒ From the selection box next to **Motor type**: select the appropriate motor for your application

⇒ In the **Parallel connection motor** field, enter the number of motors connected in parallel, if necessary. Motors connected in parallel must be of the same type and size.

Note

The steps described below also apply to commissioning an induction motor.

When commissioning a permanent-field synchronous motor, there are a few special conditions which are detailed in a separate chapter (see "Closed-loop control").

⇒ Click **Continue** >

Configuring the motor – Entering motor data

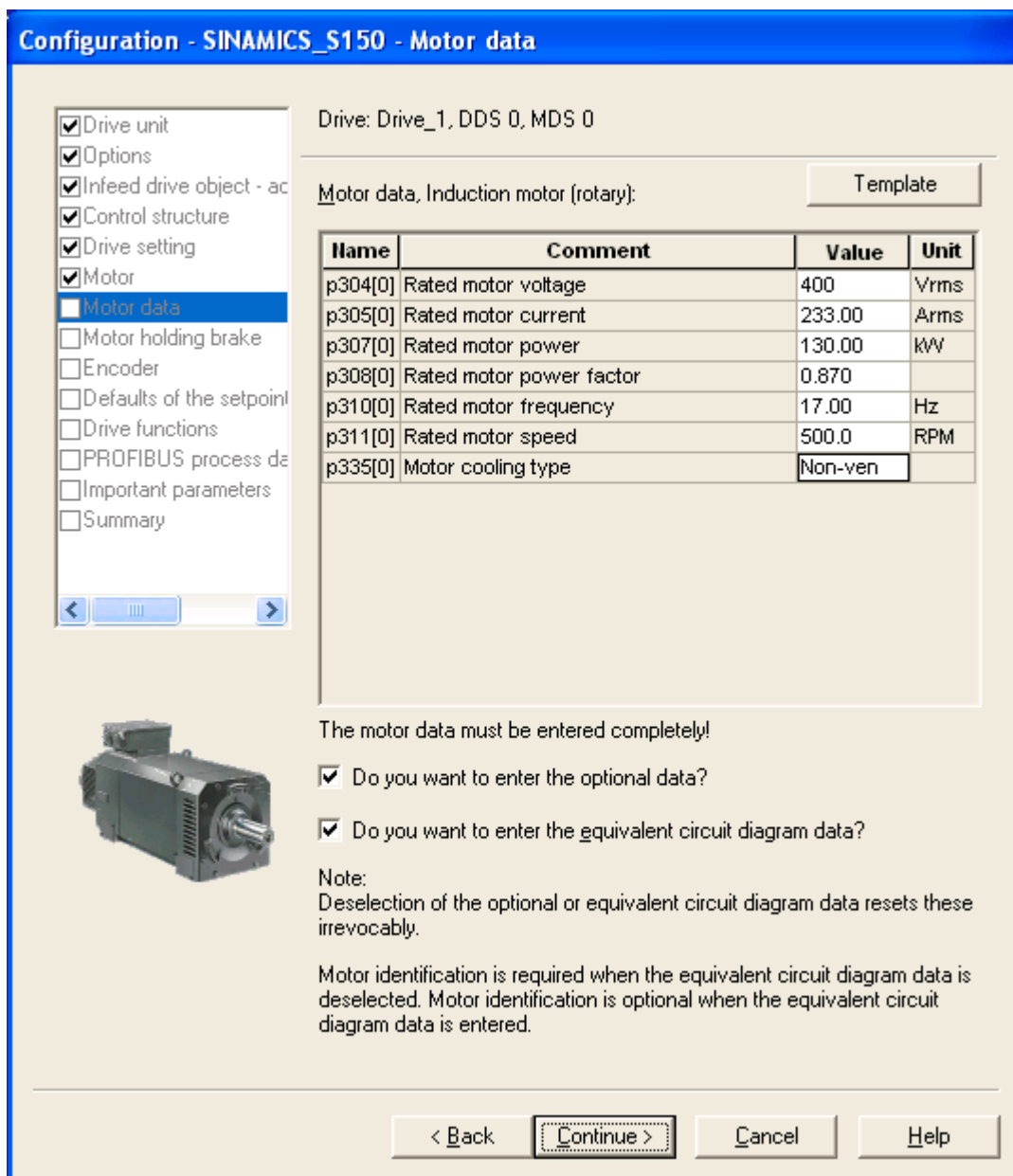


Figure 5-19 Configuring the motor – Entering motor data

⇒ Enter the motor data (see motor type plate).

⇒ If necessary, check **Do you want to enter the optional data?**

⇒ If necessary, activate **Do you want to enter the equivalent circuit diagram data?**

Note

Click **Template** to open another selection screenform where you can choose the motor used in your application from a long list of standard motor types. Select a motor from the list to enter the data stored in the system for that motor automatically in the data fields.

NOTICE

You should only check the "Do you want to enter equivalent circuit diagram data?" box if the data sheet with equivalent circuit diagram data is available. If any data is missing, an error message will be output when the system attempts to load the drive project to the target system.

⇒ Click **Continue** >

Configuring the motor – Entering optional data

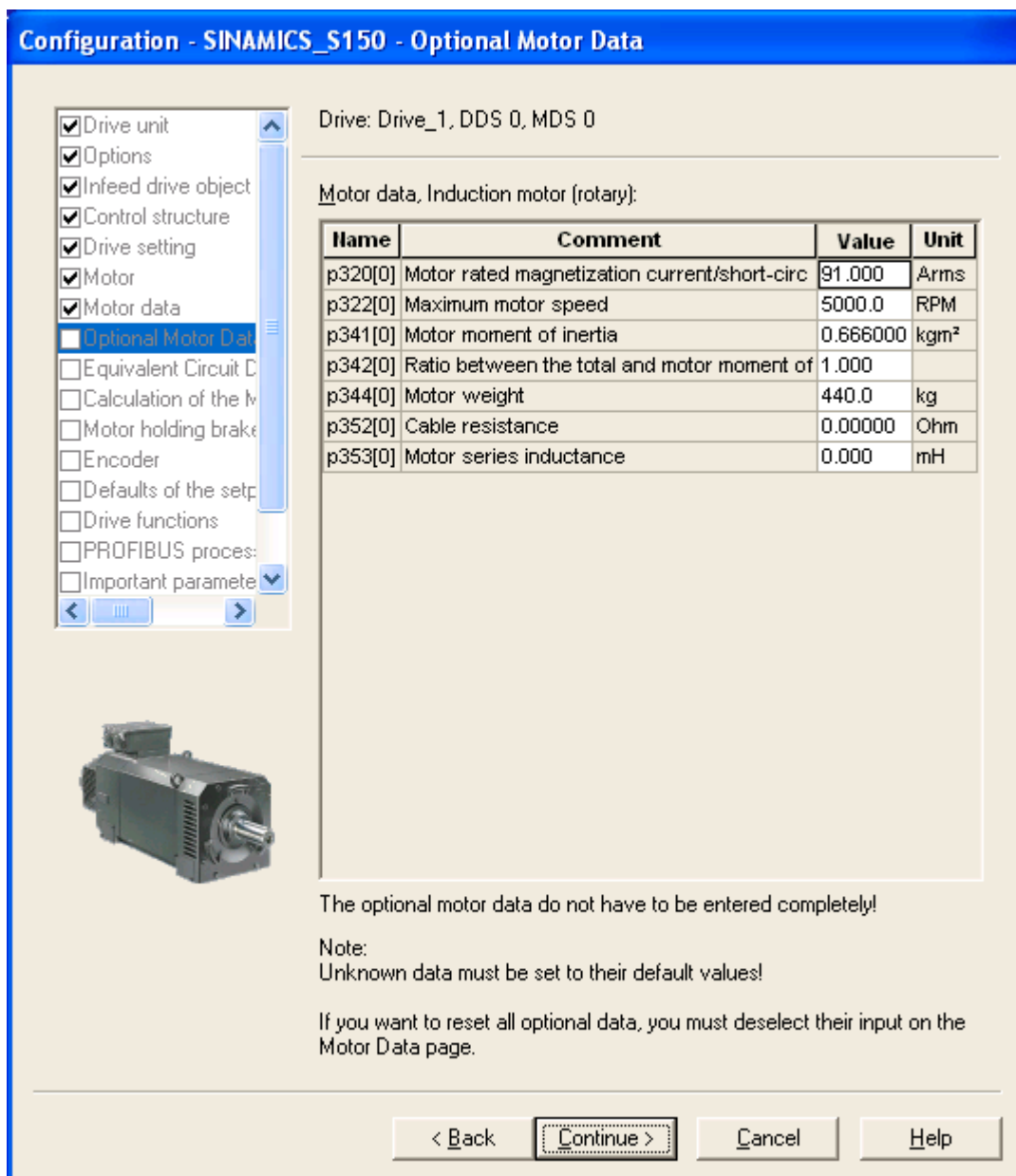


Figure 5-20 Entering optional motor data

⇒ If necessary, enter the optional motor data.

⇒ Click **Continue >**

Configuring the motor – Entering the equivalent circuit diagram data

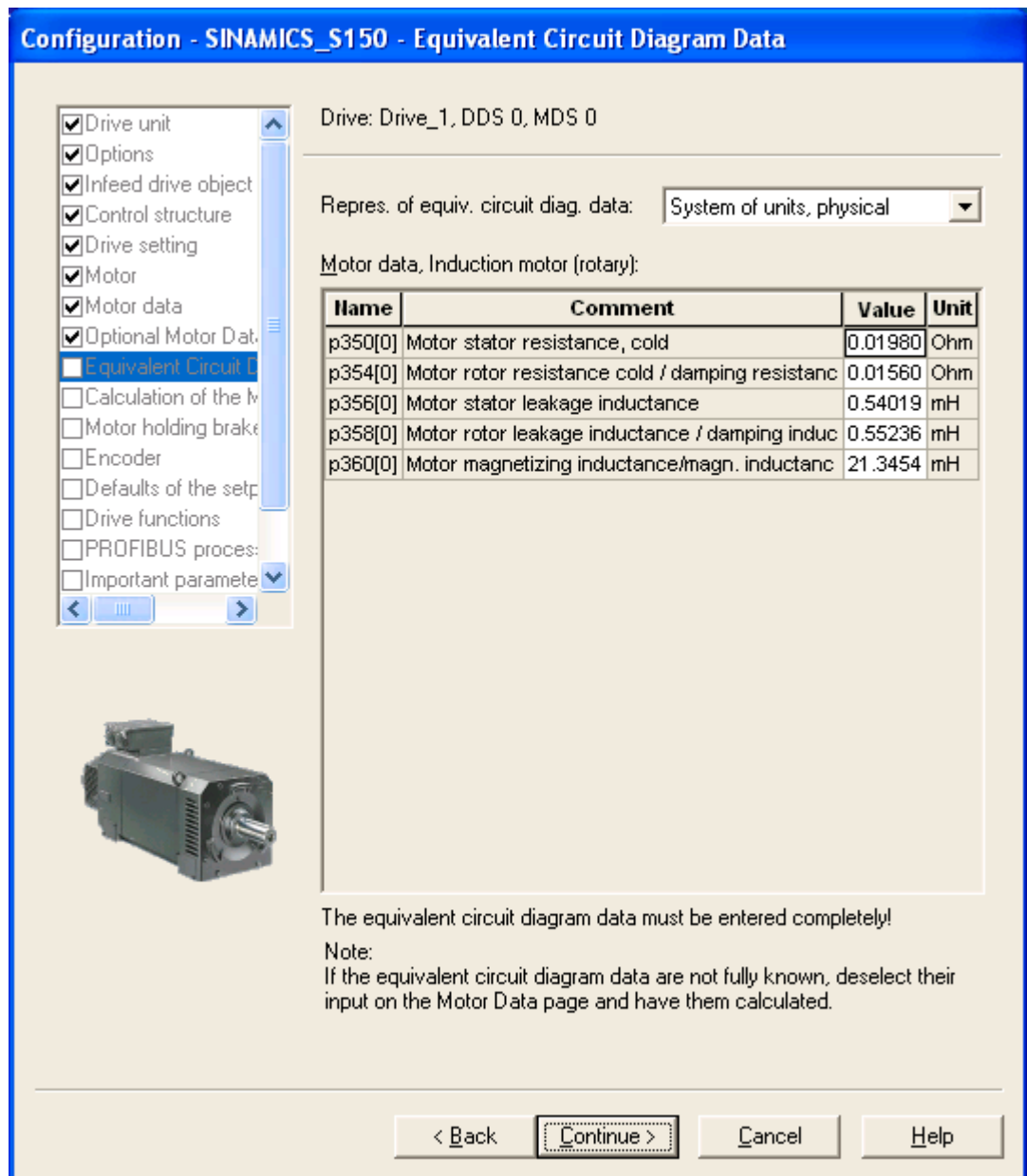


Figure 5-21 Entering equivalent circuit diagram data

- ⇒ If necessary, enter the equivalent circuit diagram data
- ⇒ Click **Continue >**

Calculating the motor/controller data

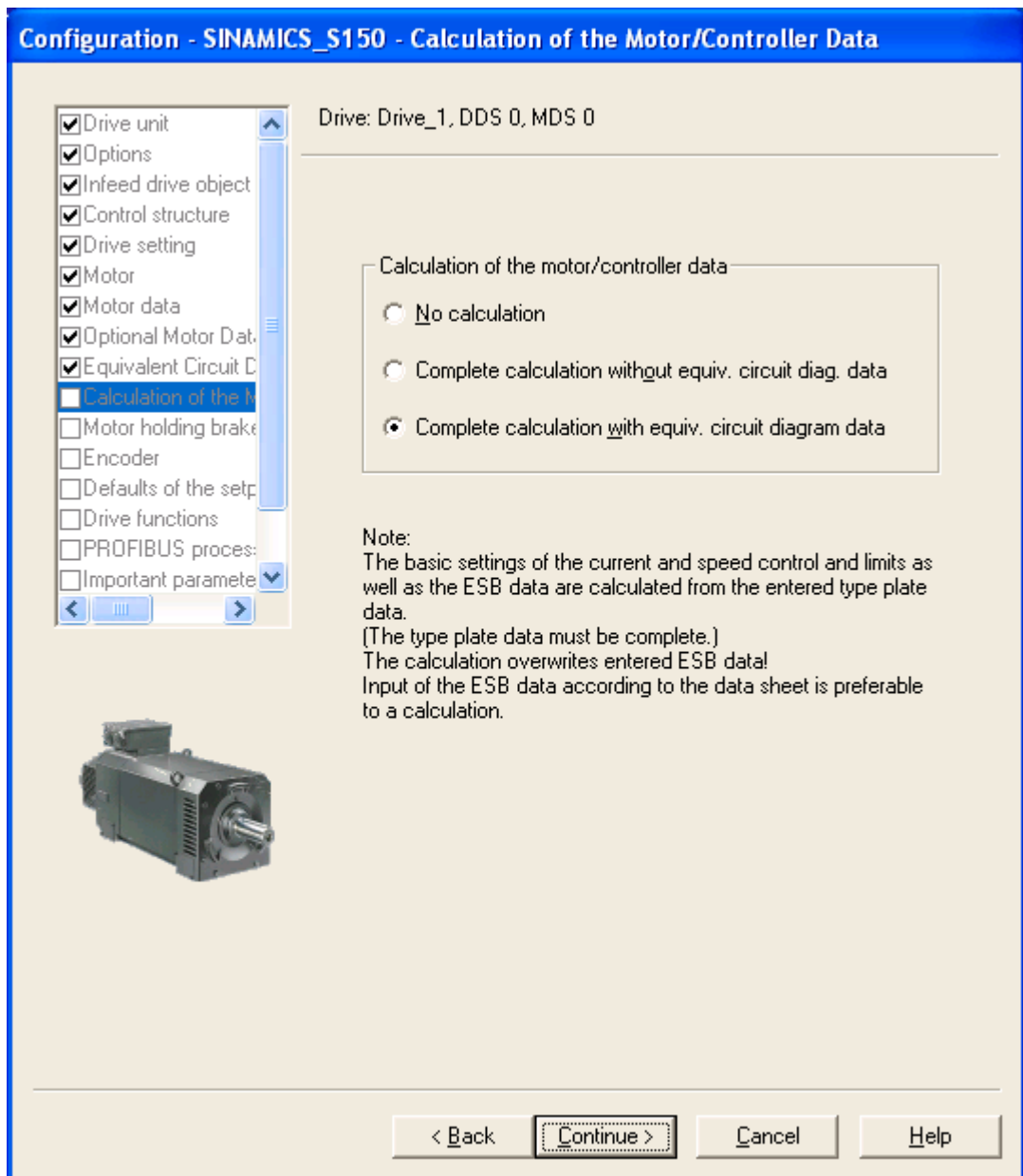


Figure 5-22 Calculating the motor/controller data

⇒ In **Calculation of the motor/controller data**, select the appropriate default settings for your device configuration.

Note

If the equivalent circuit diagram data was entered manually (see "Entering the equivalent circuit diagram data"), the motor/controller data should be calculated **without** calculating the equivalent circuit diagram data.

⇒ Click **Continue >**

Configuring the motor holding brake

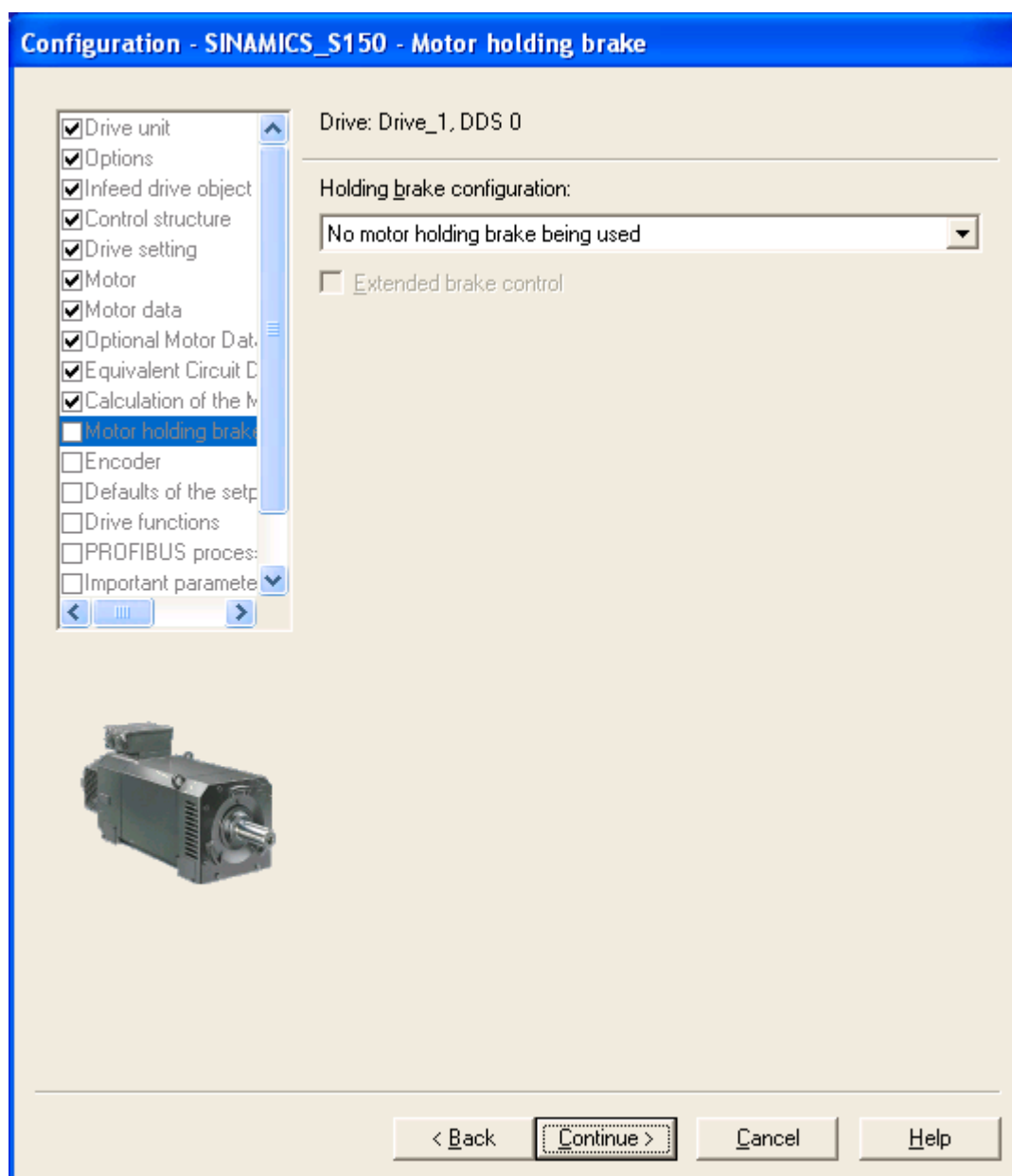


Figure 5-23 Configuring the motor holding brake

⇒ Under **Holding brake configuration**: choose the appropriate settings for your device configuration.

⇒ Click **Continue >**

Entering the encoder data (option K46 / K48 / K50)

Note

If you have specified option K46, K48, or K50 (SMC10, SMC20, or SMC30 Sensor Module), the following screen is displayed in which you can enter the encoder data.

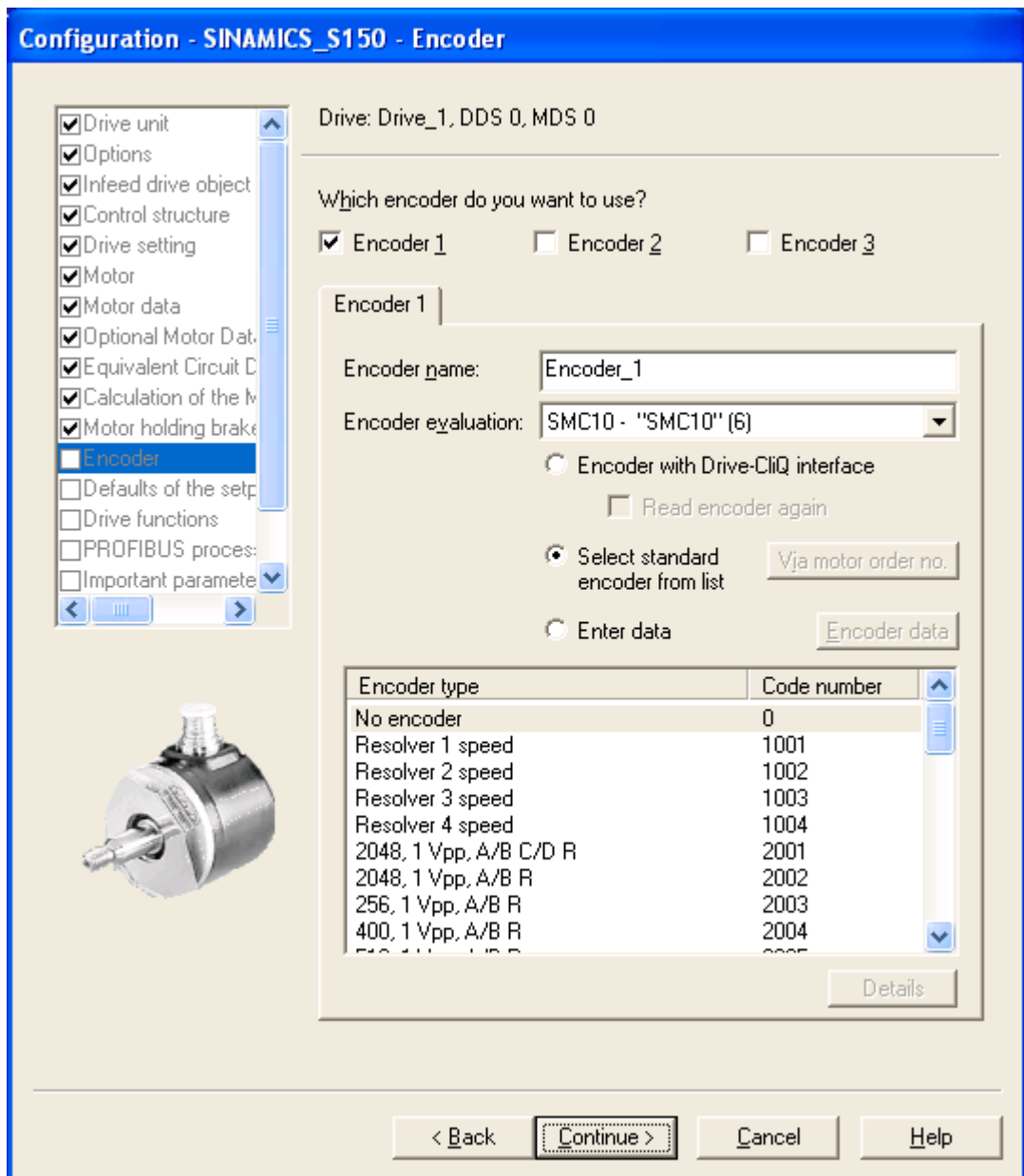


Figure 5-24 Entering the encoder data (option K46)

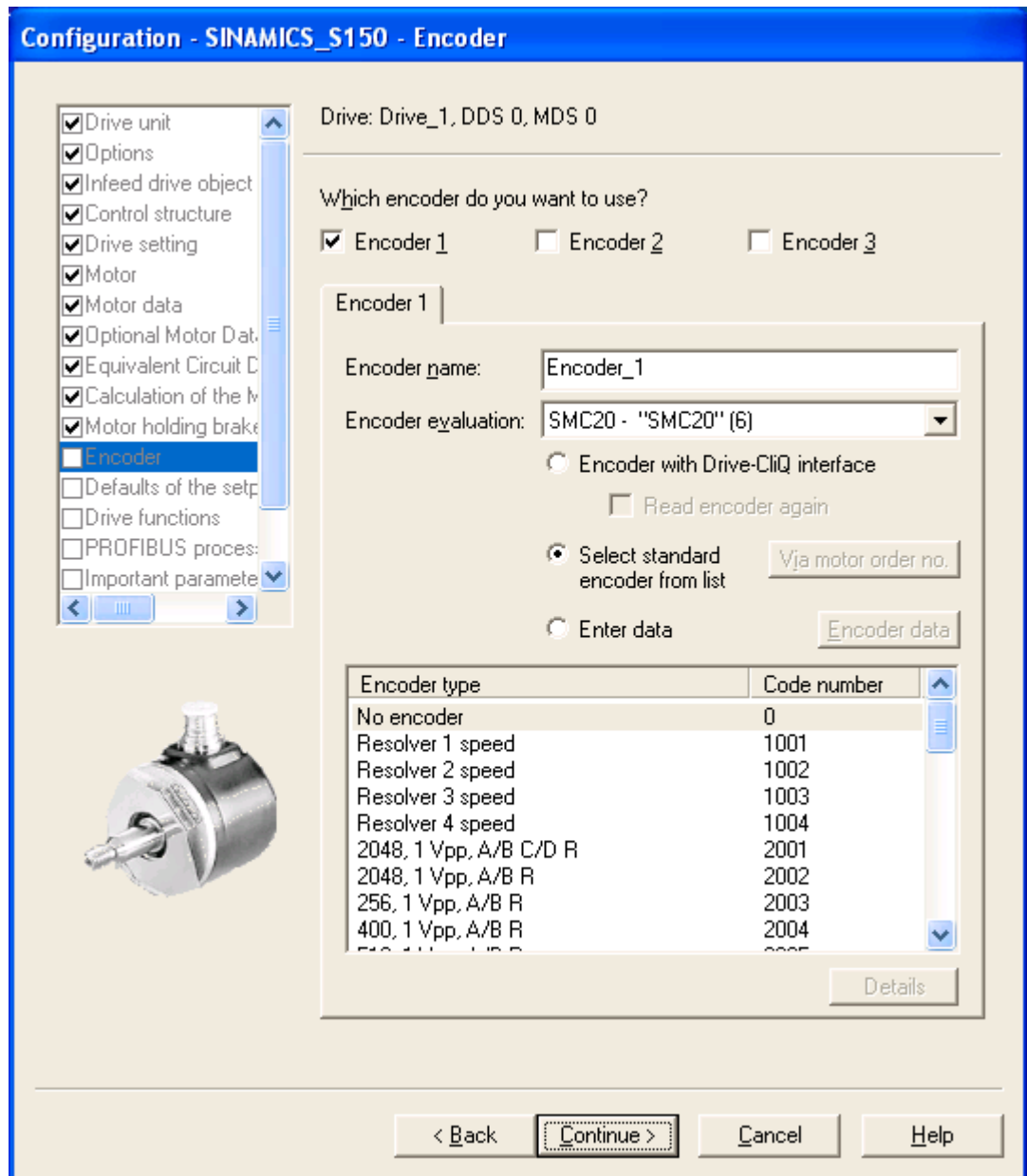


Figure 5-25 Entering the encoder data (option K48)

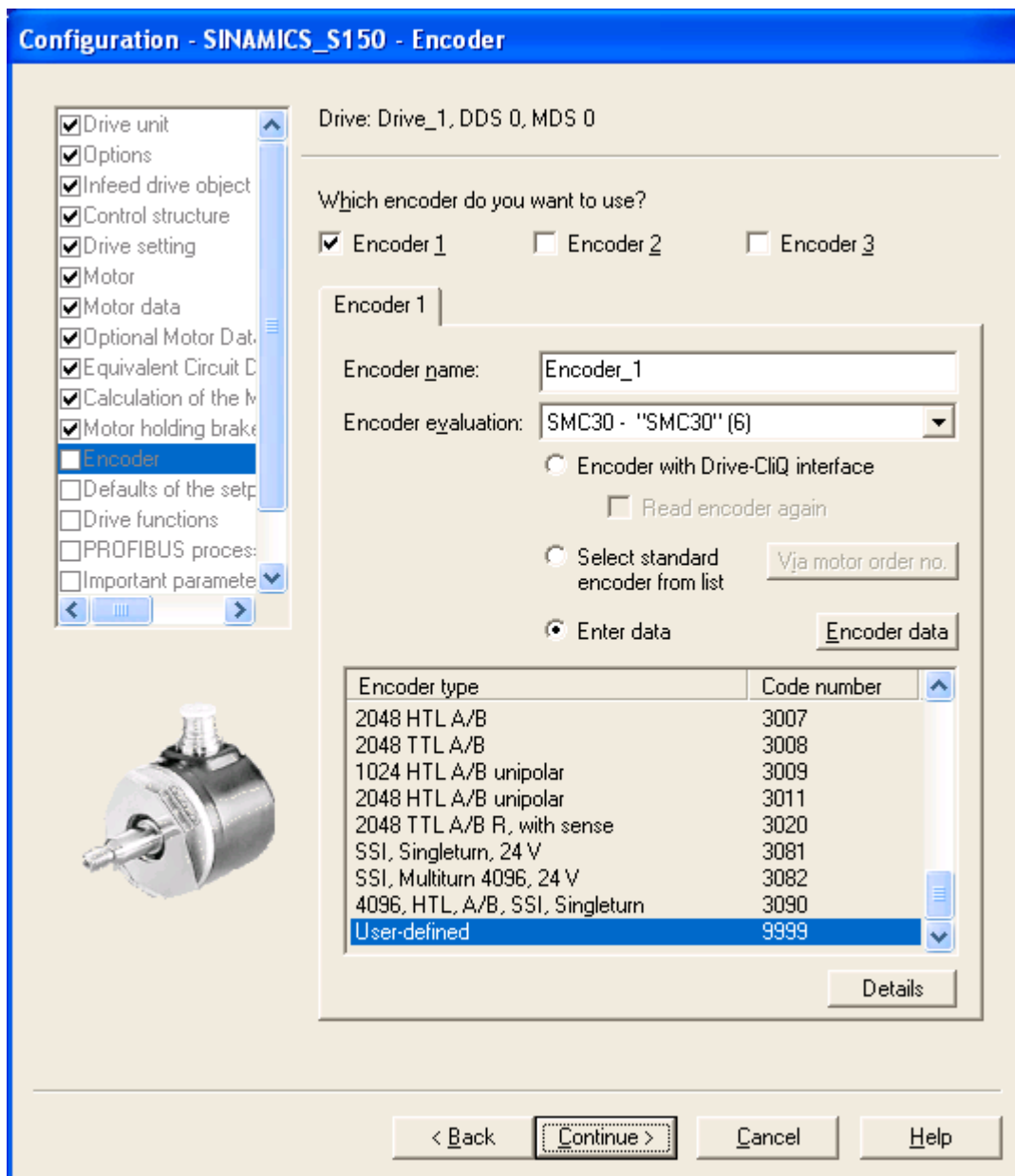


Figure 5-26 Entering the encoder data (option K50)

⇒ In the **Encoder name**: field, enter a name of your choice.

⇒ Click the **Select standard encoder from list** radio button and select one of the available encoders.

- Standard encoders with code numbers 1xxx are provided for selection when encoder module SMC10 is fitted (option K46).
- Standard encoders with code numbers 2xxx are provided for selection when encoder module SMC20 is fitted (option K48).
- Standard encoders with code numbers 3xxx are provided for selection when encoder module SMC30 is fitted (option K50).

⇒ To enter special encoder configurations, click the **Enter data** radio button and then the **Encoder data** button. The following screen (in this case an example for the HTL encoder) is displayed in which you can enter the required data.

Figure 5-27 Entering encoder data – user-defined encoder data – example: HTL encoder

⇒ Enter the required encoder data.

⇒ Click **OK**.

CAUTION

Option K50: once the encoder has been commissioned, the supply voltage (5/24 V) set for the encoder is activated on the SMC30 module. If a 5 V encoder is connected and the supply voltage has not been set correctly, the encoder may be damaged.

Default settings for setpoints/command sources

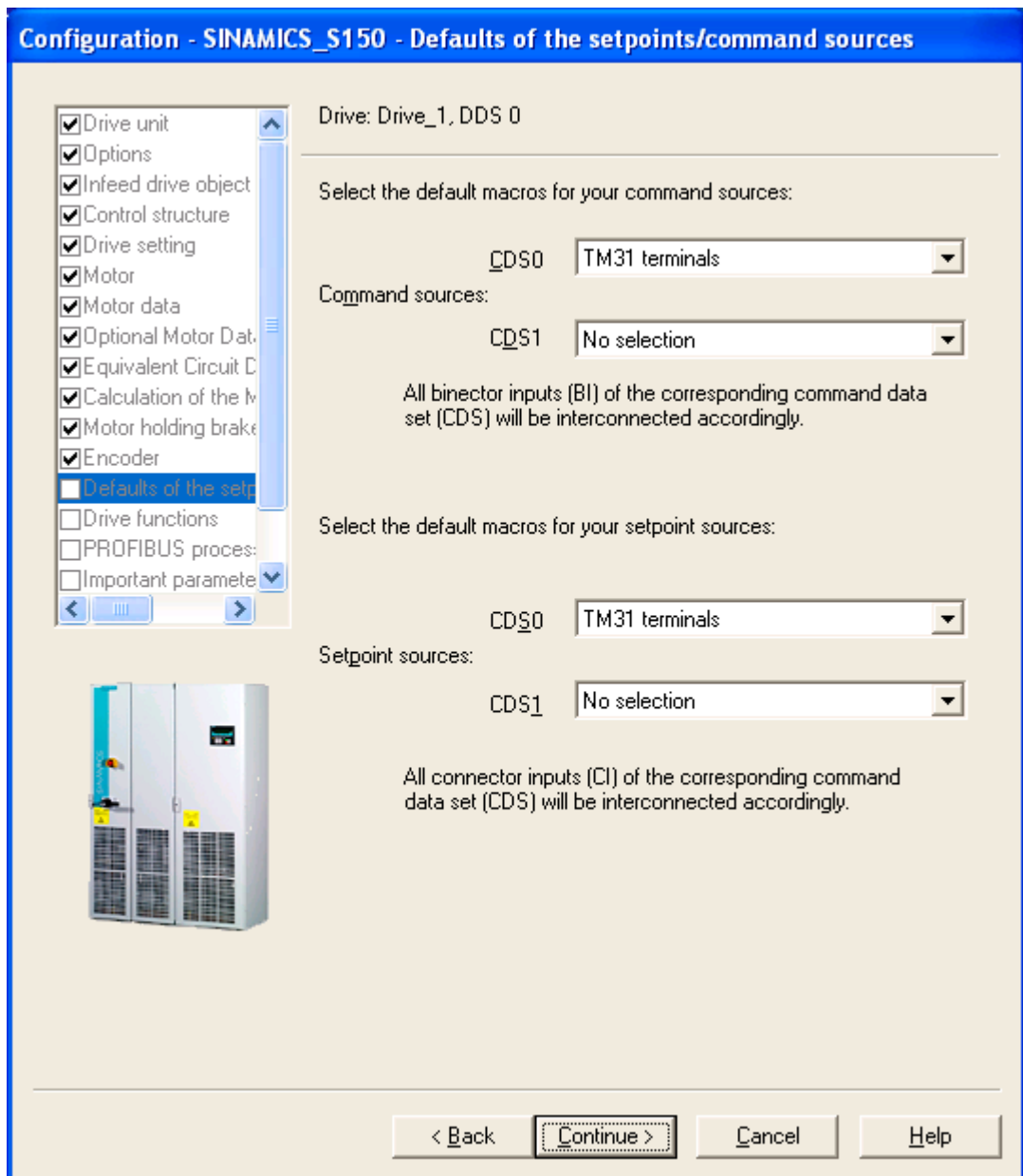


Figure 5-28 Default settings for setpoints/command sources

⇒ Under **Command sources:**, choose and **Setpoint sources:** choose the appropriate settings for your device configuration.

The following command and setpoint source options are available:

Command sources:	PROFIdrive
	TM31 terminals
	NAMUR
	PROFIdrive NAMUR
Setpoint sources:	PROFIdrive
	TM31 terminals
	Motorized potentiometer
	Fixed setpoint

Note

With SINAMICS S150, only CDS0 is normally used as a default setting for the command and setpoint sources.

Make sure that the selected default setting is compatible with the actual system configuration.

Note

The choice "no selection" is also available as default setting for the command and setpoint sources; if selected, no default settings are applied for the command and setpoint sources.

⇒ Check your default settings carefully and then click **Continue >**

Defining the technological application/motor identification

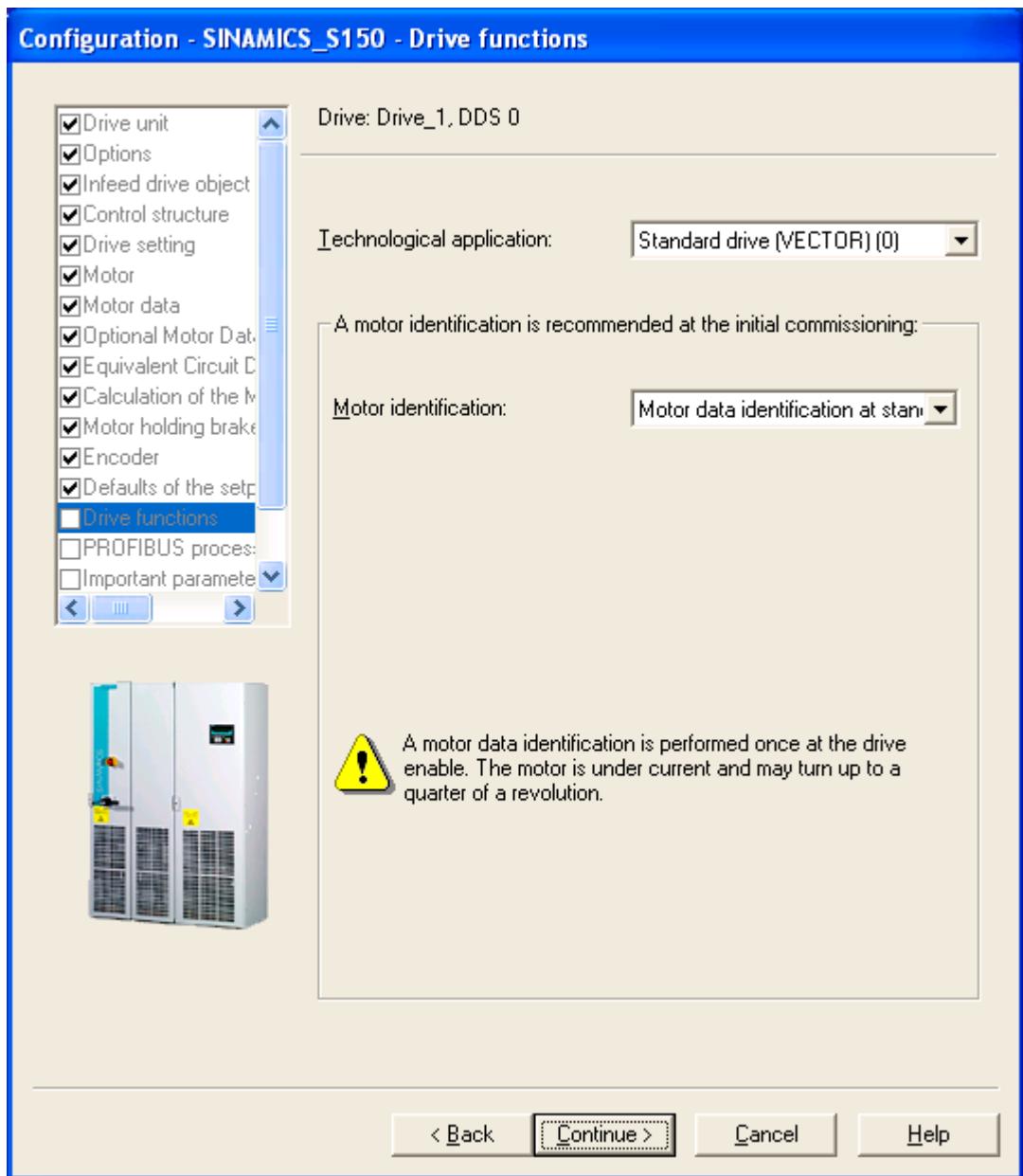


Figure 5-29 Defining the technological application/motor identification

⇒ Select the required data:

- **Technological application:**

- **"Standard drive (VECTOR) (0)"**(default setting)
Edge modulation is not enabled.
The dynamic voltage reserve is increased (10 V), which reduces the maximum output voltage.
- **"Pumps and fans (1)"**
Edge modulation is enabled.
The dynamic voltage reserve is reduced (2 V), which increases the maximum output voltage.
- **"Passive loads (for sensorless control down to f = 0) (2)"**
Controlled operation down to standstill is possible for passive loads.
These include applications in which the load cannot produce a regenerative torque on startup and the motor comes to a standstill when pulses are inhibited.

- **Motor identification:**

"Motor data identification with motor running" is normally the appropriate default setting for SINAMICS S150, especially if an encoder is used for speed control.

⇒ Click **Continue >**

Selecting the PROFIBUS message frame

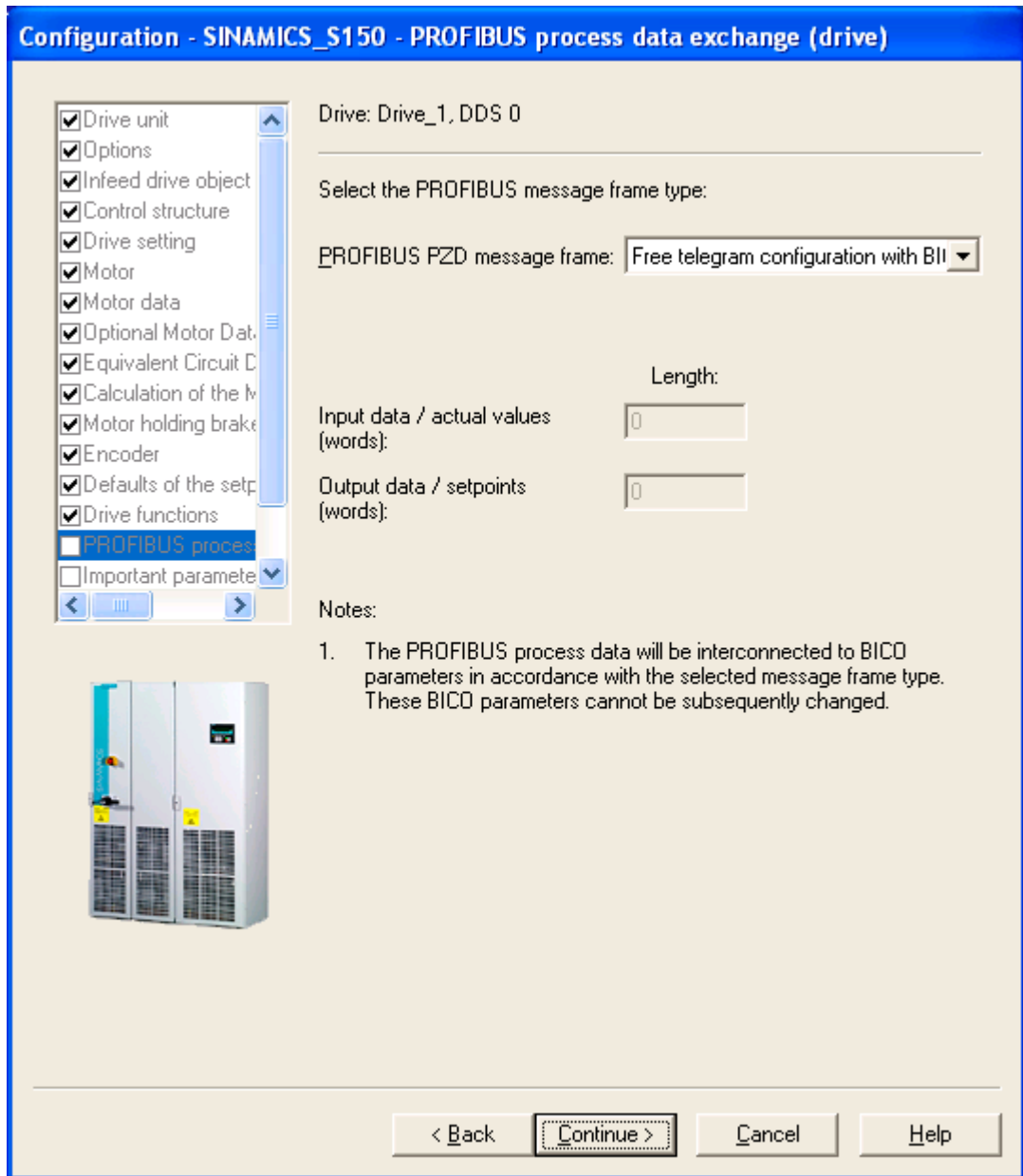


Figure 5-30 Selecting the PROFIBUS message frame

⇒ Under **PROFIBUS process data exchange (drive)**: select the PROFIBUS message frame type.

Message frame types

- Standard telegram 1
- Standard telegram 2
- Standard telegram 3
- Standard telegram 4
- VIK-NAMUR telegram 20
- SIEMENS telegram for metal industry 220
- PCS7 telegram 352
- Free telegram configuration with BICO

⇒ Click **Continue >**

Entering important parameters

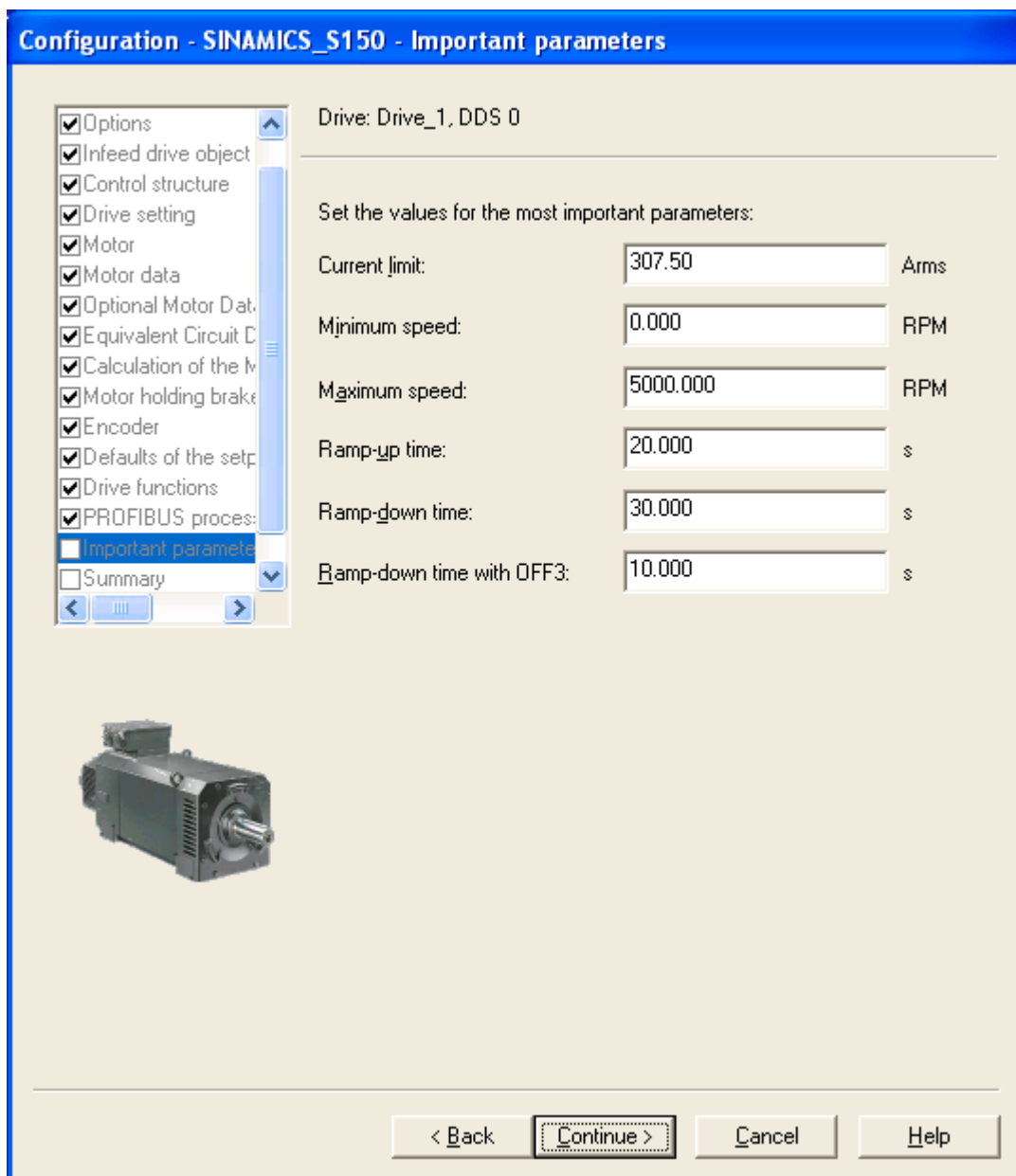


Figure 5-31 Important parameters

⇒ Enter the required parameter values.

Note

STARTER provides tool tips if you position your cursor on the required field **without clicking in the field**.

⇒ Click **Continue >**

Summary of the drive unit data

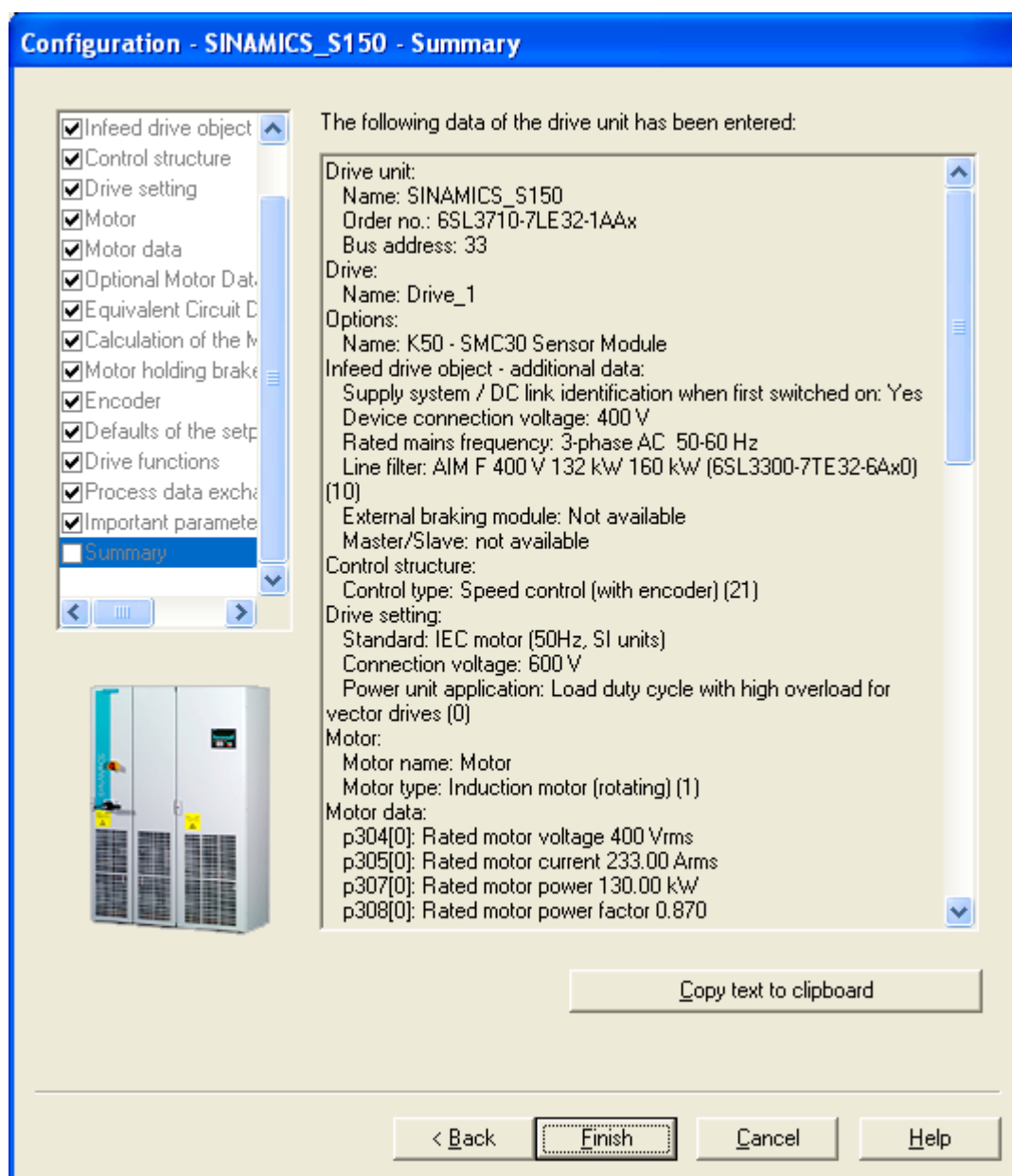


Figure 5-32 Summary of the drive unit data

⇒ You can use the **Copy to clipboard** function to copy the summary of the drive unit data displayed on the screen to a word processing program for further use.

⇒ Click **Finish**.



⇒ Save your project to the hard disk by choosing **Project > Save**.

5.3.3 Starting the drive project

You have created a project and saved it to your hard disk. You now have to transfer your project configuration data to the drive unit.

Transferring the STARTER project to the drive unit


To transfer the STARTER project you created offline to the drive unit, carry out the following steps:

Step		Selection in toolbar
1	Choose Project > Connect to target system	
2	Choose Target system > Load project to target system	

NOTICE

The project has now been loaded to the drive unit. The data is currently only stored in the volatile memory of the drive unit and not on the CompactFlash card.

To store the project data on the CompactFlash card so that it is protected in the event of a power failure, carry out the following step.

Step		Selection in toolbar
3	Choose Target system > Copy from RAM to ROM	

Note

The **Copy from RAM to ROM** icon is only active when the drive unit is selected in the project navigator.

Results of the previous steps

- You have created a drive unit project offline using STARTER.
- You have saved the project data to the hard disk on your PC.
- You have transferred the project data to the drive unit.
- You have saved the project data to the CompactFlash card so that it is protected in the event of a power failure.

Note

The STARTER commissioning tool supports complex drive system operations.

If you are confronted with any system conditions in online mode that are beyond your control, you are advised to delete the drive project from the project navigator and carefully create a new project in STARTER using the appropriate configuration data for your application.

5.3.4 Connection via serial interface

In addition to using the PROFIBUS connection, data can also be exchanged via a serial interface.

Prerequisites

The PC from which the connection is to be made must be equipped with a serial interface (COM).

Settings

1. In STARTER, choose **Project > Set PC/PG interface** and select the **serial cable (PPI)** interface.
If this is not available from the dropdown list, you first have to add it by choosing **Select**.

Note

If the interface cannot be added to the selection menu, the driver for the serial interface has to be installed.

This is located under the following path on the STARTER CD:

\\installation\starter\starter\Disk1\SerialCable_PPI\

STARTER must not be active while the driver is being installed.

2. Make the following settings. The "0" address and the transmission rate of 19.2 kbit/s are important here.

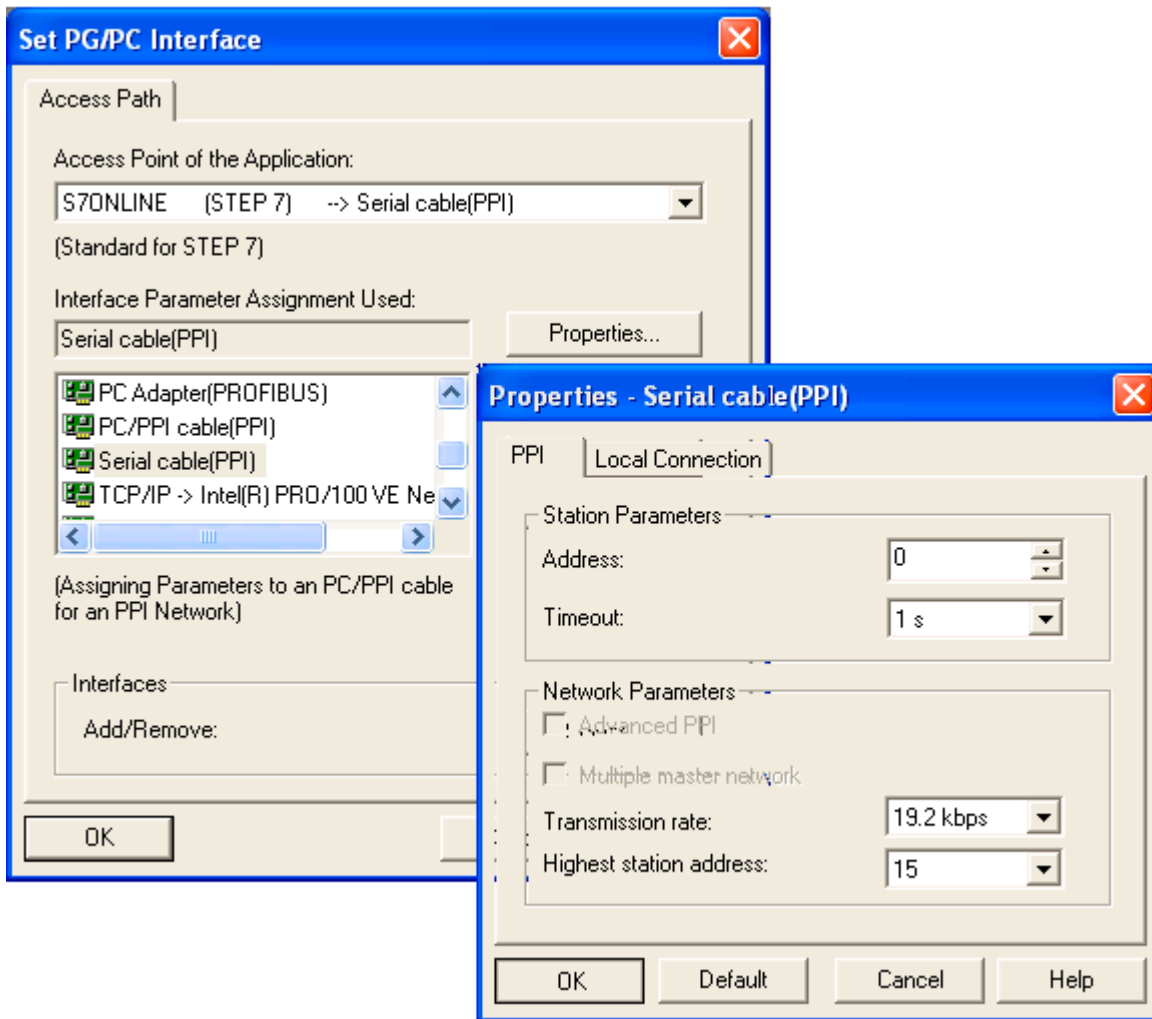


Figure 5-33 Setting the interface

3. On CU320, set bus address "3" on the Profibus address switch.

4. When creating the drive unit, also set bus address "3".

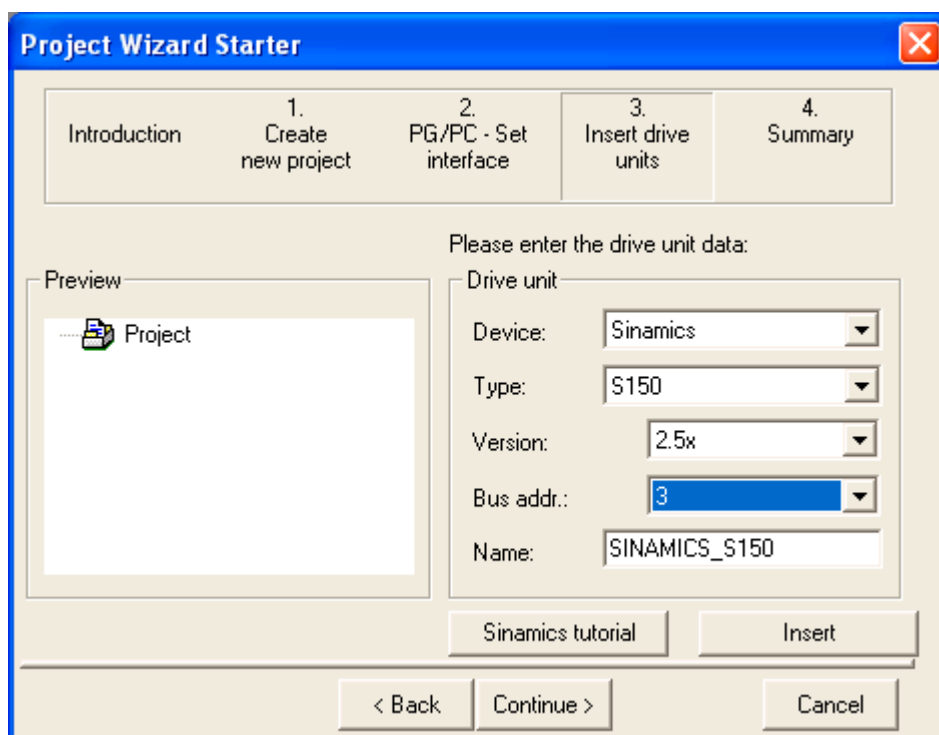


Figure 5-34 Setting the bus address

Note

The bus addresses on CU320 and on the PC must not be set the same.

5. The connecting cable from CU320 to AOP30 must be disconnected on CU320. A null modem cable must be used here to connect the PC (COM interface) and CU320. This interface must not be switched.

5.4 The AOP30 operator panel

Description

An operator panel is located in the cabinet door of the cabinet unit for operating, monitoring, and commissioning tasks. It has the following features:

- Graphical, back-lit LCD for plain-text display and a "bar display" of process variables
- LEDs for indicating the operating modes
- Help function describing causes of and remedies for faults and alarms
- Keypad for controlling drives during operation
- LOCAL/REMOTE switchover for selecting the control terminal (master control assigned to operator panel or Customer Terminal Block / PROFIBUS)
- Numeric keypad for entering setpoint or parameter values
- Function keys for prompted navigation through the menus
- Two-stage security concept to protect against accidental or unauthorized changes to settings
- Degree of protection IP 54 (when installed)

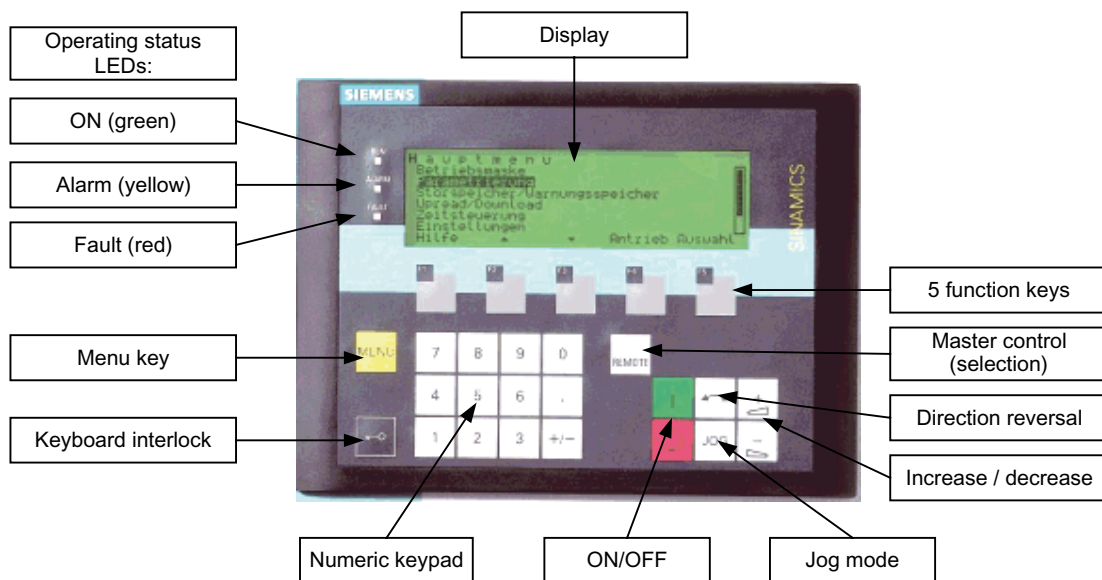


Figure 5-35 Components of the cabinet unit operator panel (AOP30)

5.5 First commissioning with the AOP30

5.5.1 First commissioning

Start screen

When the system is switched on for the first time, the Control Unit (CU320) is initialized automatically. The following screen is displayed:

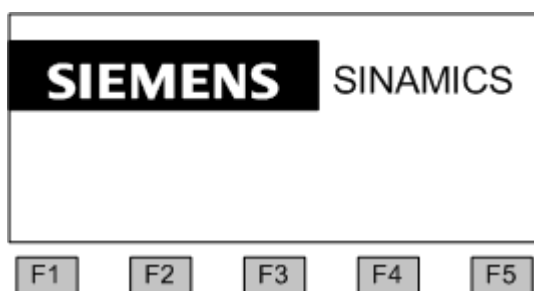


Figure 5-36 Initial screen

When the system boots up, the parameter descriptions are loaded into the operating field from the CompactFlash card.

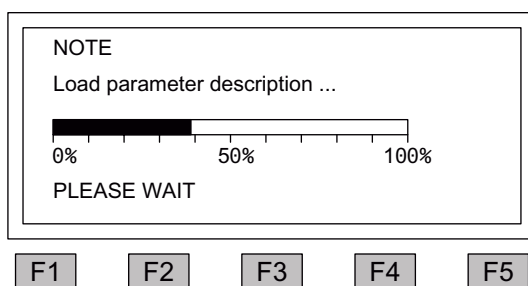
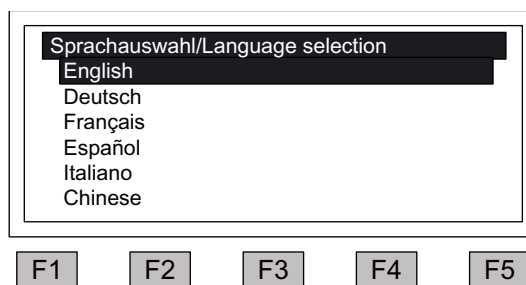


Figure 5-37 Load the parameter descriptions while booting up the system

Selecting the language

When the system is first booted up, a screen for selecting the language appears.



You can select the language in the dialog screen.

To change the language, choose <F2> or <F3>.

To select the language, choose <F5>.

Once the language has been selected, the booting up process continues.

Once the system has successfully ramped up, the drive has to be commissioned when the system is switched on for the first time after it has been delivered. The converter can then be switched on.

When the system is then ramped up again, it can be operated immediately.

Navigation within the interactive screens

Within an interactive screen, the selection boxes can usually be selected using the <F2> and/or <F3> keys. Selection fields are generally texts surrounded by a frame. When they are selected, they are highlighted with a white text on a black background.

The present value of a highlighted selection box can usually be changed by pressing <F5> "OK" and/or "Change". Another entry box then appears and the value you want is entered directly using the numerical keypad or can be selected from a list.

You can change from one interactive screen to the next or previous screen by selecting the "Next" or "Previous" selection boxes and then confirming by pressing <F5> "OK".

If a screen contains particularly important parameters, the selection field "Continue" only appears at the bottom of the screen. This is because every single parameter in this interactive screen has to be checked and/or corrected thoroughly before the next interactive screen can be accessed.

5.5.2 Basic commissioning

Entering the motor data

During initial commissioning, you have to enter motor data using the operator panel. Use the data shown on the motor type plate.

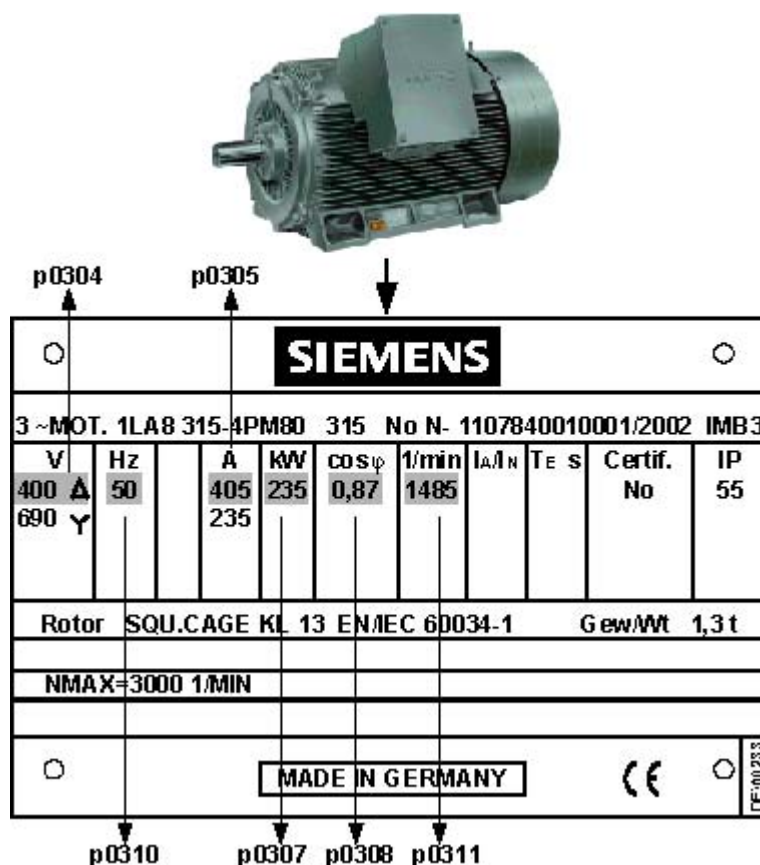


Figure 5-38 Example of a motor type plate

Table 5- 1 Motor data

	Parameter no.	Values	Unit
System of units for line frequency and entering motor data	p0100	0 1	IEC [50 Hz / kW] NEMA [60 Hz / hp]
Motor:			
Rated voltage	p0304		[V]
Rated current	p0305		[A]
Rated power	p0307		[kW] / [hp]
Rated power factor cos φ (at p0100 = 0 only)	p0308		
Rated efficiency η (at p0100 = 1 only)	p0309		[%]
Rated frequency	p0310		[Hz]
Rated speed	p0311		[min-1] / [rpm]

First commissioning: infeed

Table 5- 2 Entering the infeed data

{2:A_INF} First IBN feed-in

p0210 Supply voltage 400.00 Veff

p0211 Rated line frequency 50.00 Hz

p3410 INF Ident_type 5:Res ID RegA

p0840cON/OFF1 {03}0863.01

Help+ ▲ ▼ Change

F1 F2 F3 F4 F5

↑ ↓

Line data ident.
If necessary, start with LOCAL
and ON key

Enter the line infeed voltage in V and the line frequency in Hz.

Select the line identification (do not change the default setting).

Entry for the origin of the ON/OFF1 command.

Navigate within the selection fields with <F2> and <F3>.

Activate your selection with <F5>.

Once you have entered the final value, choose "Continue" to exit the screen.

Basic commissioning: Selecting the motor type and entering the motor data

{3:VECTOR} motor standard/motor type

Contin

p0100 Motor Standard IEC/NEMA 0:IEC[50Hz/kW]

p0300mMotor type selection 1:Async_motor

Contin

Help ▲ ▼ OK

F1 F2 F3 F4 F5

You can select the motor standard and type in the dialog screen.

The following is defined for the motor standard:

0: Line frequency 50 Hz, motor data in kW
1: line frequency 60 Hz, motor data in hp

The following selection options are available for the motor type:

1: Induction motor
2: Permanent-field synchronous motor
5: Synchronous motor (separately-excited)

To navigate through the selection fields, choose <F2> or <F3>.

To activate a selection, choose <F5>.

Entering motor data specified on the type plate

To navigate through the selection fields, choose <F2> or <F3>.

To activate a selection, choose <F5>.

To change a parameter value, navigate to the required selection field and activate with <F5>.

The system displays another window in which you can:

- Enter the value directly, or
- select the value from a list.

When you have finished entering the motor data, choose "Continue" underneath the final parameter value and activate your entries with <F5>.

{3:VECTOR} Motor parameters m:0

Back

p0210 Supply voltage 400 V

p0304mMot U_rated 400.00 Vrms

p0305mMot I_rated 405.00 Arms

p0307mMot P_rated 235.00 kW

Help ▲ ▼ OK

F1 F2 F3 F4 F5

{3:VECTOR} Motor parameters m:0

p0308mMot cosphi_rated 0.870

p0310mMot f_rated 50.00 Hz

p0311mMot n_rated 1485.00 rpm

p0335mMotor cooling type 0:natural cooling

Contin

Help ▲ ▼ OK

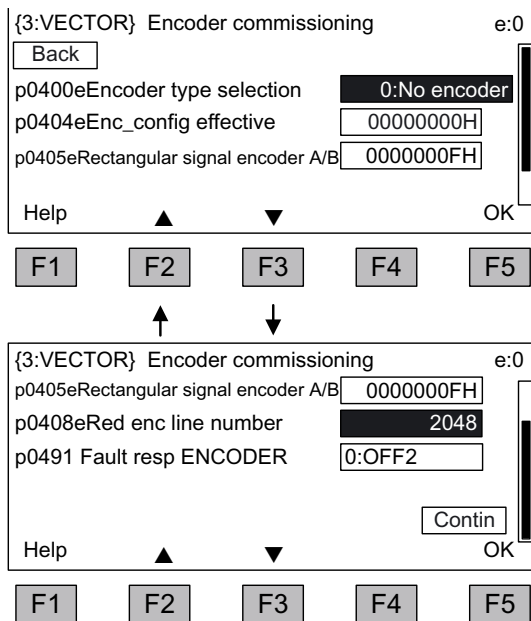
F1 F2 F3 F4 F5

Note

The steps described below also apply to induction motors.

When commissioning a permanent-field synchronous motor (p0300 = 2), there are a few special conditions that apply, which are detailed in a separate chapter (see "Setpoint channel and closed-loop control/Permanent-field synchronous motors").

Basic commissioning: Entering the encoder data (if available)



When the SMC10/SMC20/SMC30 is connected for encoder evaluation (with options K46, K48, and K50), it is recognized by the AOP30 and a screen is displayed in which you can enter the encoder data.

Navigate within the selection fields with <F2> and <F3>.

Activate your selection with <F5>.

Predefined encoders can be easily set by selecting parameter p0400 (encoder type selection):

Encoders for SMC10:

- 1001: Resolver 1 speed
- 1002: Resolver 2 speed
- 1003: Resolver 3 speed
- 1004: Resolver 4 speed

Encoders for
SMC20:

2001:	2048, 1 Vpp, A/B C/D R
2002:	2048, 1 Vpp, A/B R
2003:	256, 1 Vpp, A/B R
2004:	400, 1 Vpp, A/B R
2005:	512, 1 Vpp, A/B R
2010	18000, 1 Vpp, A/B R interval-coded
2050:	Encoder with EnDat interface identified
2051:	2048, 1 Vpp, A/B, EnDat, Multiturn 4096
2052:	32, 1 Vpp, A/B, EnDat, Multiturn 4096
2053:	512, 1 Vpp, A/B, EnDat, Multiturn 4096
2054:	16, 1 Vpp, A/B, EnDat, Multiturn 4096
2055:	2048, 1 Vpp, A/B, EnDat, Singleturn
2081:	2048, 1 Vpp, A/B, SSI, Singleturn
2082:	2048, 1 Vpp, A/B, SSI, Multiturn 4096
2110:	4000 nm, 1 Vpp, A/B R interval-coded
2111:	20000 nm, 1 Vpp, A/B R interval-coded
2112:	40000 nm, 1 Vpp, A/B R interval-coded
2151::	16000 nm, 1 Vpp, A/B, EnDat, resolution 100 nm

Encoders for
SMC30:

3001:	1024 HTL A/B R at X521/X531
3002:	1024 TTL A/B R at X521/X531
3003:	2048 HTL A/B R at X521/X531
3005:	1024 HTL A/B at X521/X531
3006:	1024 TTL A/B at X521/X531
3007:	2048 HTL A/B at X521/X531
3008:	2048 TTL A/B at X521/X531
3009	1024 HTL A/B unipolar at X521/X531
3011:	2048 HTL A/B unipolar at X521/X531
3020:	2048 TTL A/B R with sense to X520
3081:	SSI, Singleturn, 24 V
3082:	SSI, Multiturn 4096, 24 V
3090:	4096, HTL, A/B, SSI, Singleturn

Note

The chapter ("Electrical installation") contains connection examples for standard encoders.

Note

If the connected encoder does not match any of the encoders predefined in p0400, follow the simple procedure below for entering the encoder data:

- Via p0400, select an encoder type whose data is similar to that of the connected encoder.
- Select "User-defined" (p0400 = 9999). Previously set values are stored here.
- Adjust the bit fields of p0404, p0405, and p0408 to the data for the connected encoder.

Table 5- 3 Meaning of the bit settings for p0404

Bit	Meaning	Value 0	Value 1
20	Voltage 5 V	No	Yes
21	Voltage 24 V	No	Yes

Table 5- 4 Meaning of the bit settings for p0405

Bit	Meaning	Value 0	Value 1
0	Signal	Unipolar	Bipolar
1	Level	HTL	TTL
2	Track monitoring	None	A/B <> -A/B
3	Zero pulse	24 V unipolar	Same as A/B track

CAUTION
Once the encoder has been commissioned, the supply voltage (5/24 V) set for the encoder is activated on the SMC30 module. If a 5 V encoder is connected and the supply voltage has not been set correctly via p0404 (bit 20 = "Yes", bit 21 = "No"), the encoder may be damaged.

Basic commissioning: Entering the basic parameters

{3:VECTOR} Basic commissioning

Back Contin

p0230 Drv filter type 0:No filter

p0700cMacro BI 6:TerminalsTM31

p1000cMacro CI n_set 2:TerminalsTM31

Help ▲ ▼ OK

F1 F2 F3 F4 F5

↑ ↓

{3:VECTOR} Basic commissioning d:0

p1070cMain setpoint {04}04055[000]

p1080dMinimum speed 0.000 rpm

p1082dMaximum speed 1500.000 rpm

p1120dHLG Ramp-up time 20.000 s

Help ▲ ▼ OK

F1 F2 F3 F4 F5

↑ ↓

{3:VECTOR} Basic commissioning d:0

p1120dHLG Ramp-up time 20.000 s

p1121dHLG Return time 30.000 s

p1135dHLG OFF3 t_Return 10.000 s

Help ▲ ▼ Contin OK

F1 F2 F3 F4 F5

Final confirmation

Back

Permanent parameter transfer
execute with 'continue' and OK

Help ▼ Contin OK

F1 F2 F3 F4 F5

Entering the basic commissioning parameters:

If a sine-wave filter (option L15) is connected, it must be activated in p0230 (p0230 = 3) otherwise it could be destroyed.

p0700: Preset command source

5: PROFIdrive

6: TM31 terminals

7: Namur

10: PROFIdrive Namur

p1000: Preset setpoint source

1: PROFIdrive

2: TM31 terminals

3: Motorized potentiometer

4: Fixed setpoint

Once a setpoint source has been selected (p1000), the main setpoint p1070 is defaulted accordingly.

To navigate through the selection fields, choose <F2> or <F3>.

To activate a selection, choose <F5>.

To change a parameter value, navigate to the required selection field and activate with <F5>.

Another window appears in which you can

- enter the required value directly, or
- select the value from a list.

Final confirmation

Confirm the basic parameters to save them.

Once you have selected "Continue" and activated your entries with <F5>, the basic parameters you entered are permanently saved and the calculations required for closed-loop control are carried out.

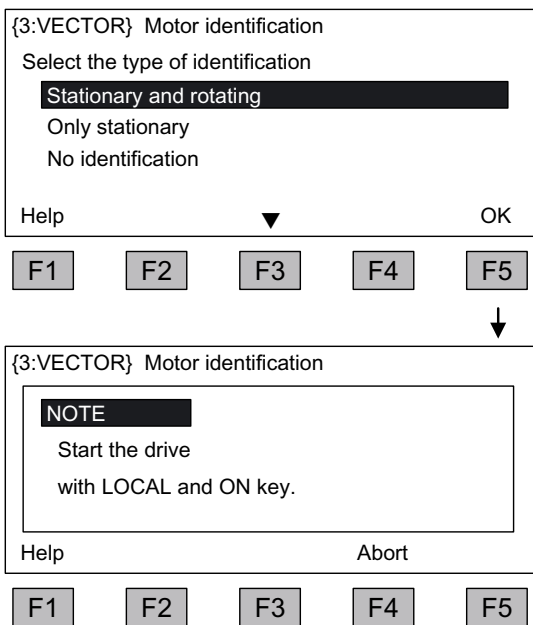
NOTICE

A filter at the motor end must be entered in p0230 (option L08 – motor reactor: p0230 = 1, option L10 – dV/dt filter with Voltage Peak Limiter: p0230 = 2, option L15 – sine-wave filter: p0230 = 3). Motor control will not otherwise function properly. When p0230 = 4 "Sine-wave filter, third-party", a separate sine-wave filter can be entered. An input screen then appears in which the specific filter can be entered.

Note

The choice "no selection" is also available as default setting for the command and setpoint sources; if selected, no default settings are applied for the command and setpoint sources.

Basic commissioning: Motor identification



Selecting motor identification

To navigate through the selection fields, choose <F2> or <F3>. To activate a selection, choose <F5>.

Stationary measurements increase control performance as deviations in the electrical characteristic values are minimized on account of deviations in the material properties and manufacturing tolerances.

Rotary measurements determine the data required (e.g. moment of inertia) for setting the speed controller. They also measure the magnetization characteristic and rated magnetization current of the motor.

To activate this function, press the LOCAL key (wait until the LED in the LOCAL key lights up) and then ON.

If motor identification is not carried out, the motor controller is using the motor characteristic values calculated from the type plate data rather than the measured values.

Note

When motor identification is complete, press the OFF key to cancel the power-on inhibit.

 **DANGER**

When the rotating measurement is selected, the drive triggers movements in the motor that can reach the maximum motor speed. The emergency STOP functions must be fully operational during commissioning. To protect the machines and personnel, the relevant safety regulations must be observed.

Note

If a fault is present when the stationary or rotary measurement is selected, motor identification cannot be carried out.

Before rectifying the fault, you have to choose "No identification" and close the screen.

Motor identification can then be selected again via <MENU> - <Commissioning/service> - <Drive commissioning> - <Motor identification>.

5.6 Status after commissioning

LOCAL mode (control via operator panel)

- You switch to LOCAL mode by pressing the "LOCAL/REMOTE" key.
- Control (ON/OFF) is carried out via the "ON" and "OFF" keys.
- You specify the setpoint using the "increase" and "decrease" keys or by entering the appropriate numbers using the numeric keypad.

Analog outputs

- The actual speed (r0063) is output as a current output in the range 0 to 20 mA at analog output 0 (X522:2 and 3).
A current of 20 mA is equal to the maximum speed in p1082.
- The actual current value (r0068) is output as a current output in the range 0 to 20 mA at analog output 1 (X522:5 and 6).
A current of 20 mA corresponds to the current limit (p0640), which is set to 1.5 x the rated motor current (p0305).

Digital outputs

- The "enable pulses" signal is output at digital output 0 (X542:2 and 3).
- The "no fault active" signal is output at digital output 1 (X542:5 and 6) (fail safe).
- The "ready to start" signal is output at digital output 8 (X541:2).

5.7 Commissioning an encoder with gear factor

Description

When encoders are commissioned (p0010 = 4), a gearbox must be parameterized by means of parameters p0432 (counter), p0433 (denominator), and p0410 (sign).

To ensure that the commutation position can be accurately determined from the encoder angle, the following applies:

- For resolvers:

$$\frac{z_{p_Motor}}{z_{p_Resolver}} \times \frac{1}{n} \geq 1, \text{ Integer} \quad , z_p = \text{no. of poles}$$

- For all other absolute encoders:

$$\frac{z_{p_Motor}}{n} \geq 1, \text{ Integer} \quad , z_p = \text{no. of poles}$$

- Where n is the gear factor

$$n = \frac{\text{Encoder speed}}{\text{Motor speed}} = \frac{p0432}{p0433}$$

The encoder commissioning program ensures that this uniqueness condition is observed and, if necessary, prevents the system from exiting the commissioning program or outputs an error message.

Sign bit p0410 inverts the calculated encoder angle and the speed, thereby yielding a negative gear factor.

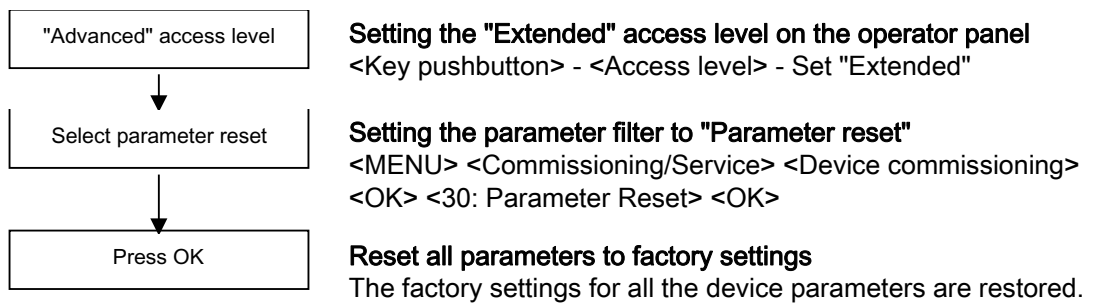
5.8 Parameter reset to factory settings

The factory settings represent the defined original status of the device on delivery.

Resetting the parameters to the factory settings means that all the parameter settings made since the system was delivered are reset.


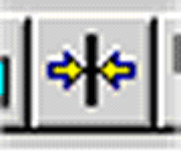
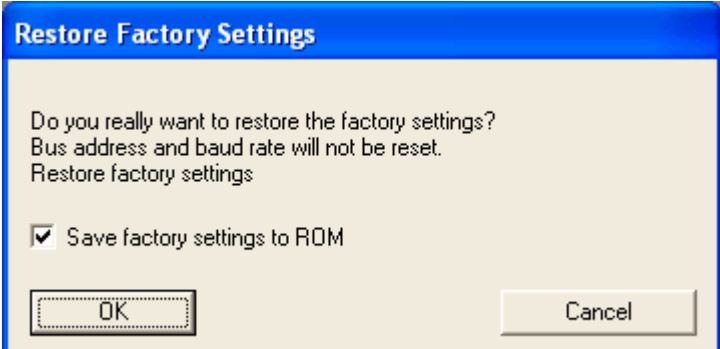

Resetting Parameters via AOP30

Table 5- 5 Procedure for resetting parameters to the factory settings with AOP30



Parameter reset via STARTER

With STARTER, the parameters are reset in online mode. The required steps are described below:

Step	Selection in toolbar
Choose Project > Connect to target system	
Click the drive unit whose parameters you want to reset to the factory settings and click Restore factory settings icon in the toolbar.	
To confirm, click OK . 	
Choose Target system > Copy from RAM to ROM	

Note

The **Copy from RAM to ROM** icon is only active when the drive unit is selected in the project navigator.

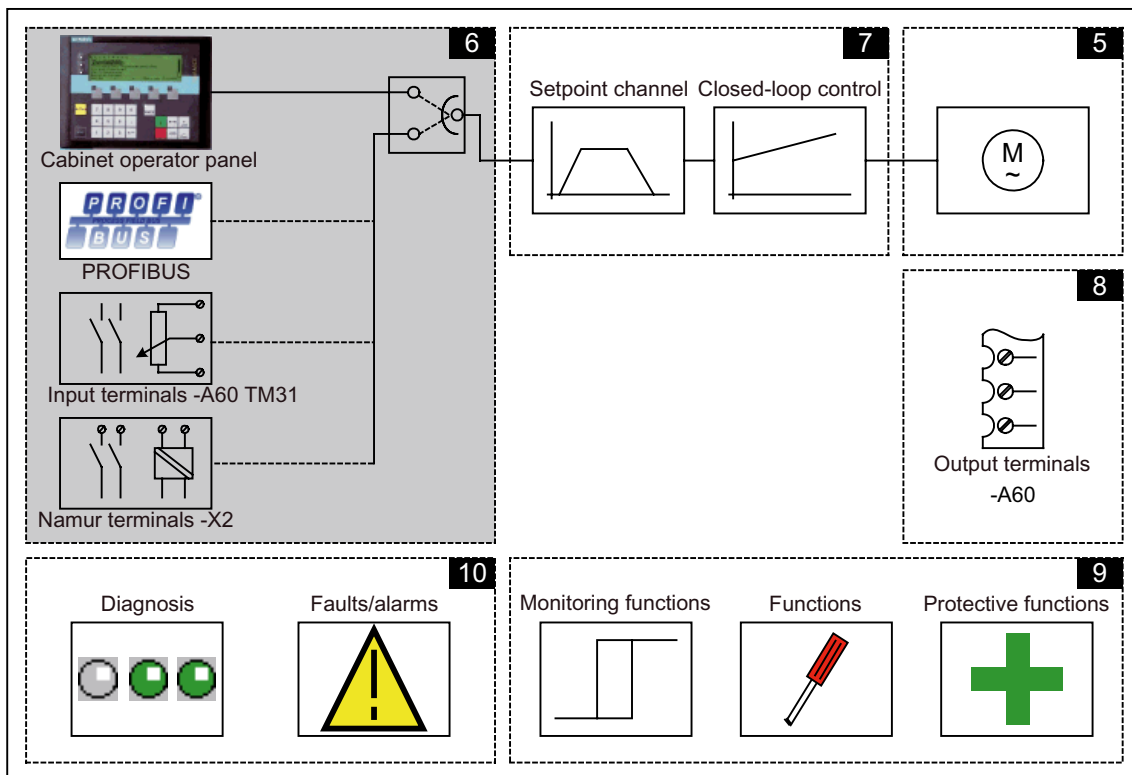
When the parameters have been reset to the factory settings, initial commissioning needs to be carried out.

Operation

6.1 Chapter content

This chapter provides information on the following:

- Basic information about the drive system
- Selecting command sources via:
 - PROFIdrive
 - Terminal strip
 - NAMUR terminal block
- Specifying setpoints via:
 - PROFIdrive
 - Analog inputs
 - Motorized potentiometer
 - Fixed setpoints
- Control via the AOP30 operator panel



6.2 General information about command and setpoint sources

Description

Four default settings are available for selecting the command sources and four for selecting the setpoint sources for the SINAMICS S150 cabinet unit. The choice "no selection" is also available; if selected, no default settings are applied for the command and setpoint sources.

Command sources

- PROFIdrive
- TM31 terminals
- NAMUR
- PROFIdrive NAMUR

Setpoint sources

- PROFIdrive
- Analog inputs
- Motorized potentiometer
- Fixed setpoints

The various assignments are explained in the following sections.

Note

Make sure that the default settings you choose during commissioning are compatible with the cabinet configuration (see "Commissioning")

Emergency STOP signals (L57, L59, and L60) and motor protection signals (L83 and L84) are always active (regardless of the command source).

Function diagrams

To supplement these Operating Instructions, the documentation folder contains simplified function diagrams describing the operating principle.

The diagrams are arranged in accordance with the chapters in the Operating Instructions. The page numbers (6xx) describe the functionality in the following chapter.

At certain points in this chapter, reference is made to function diagrams with a 4-digit number. These are stored on the documentation CD in the "SINAMICS S List Manual", which provides experienced users with detailed descriptions of all the functions.

6.3 Basic information about the drive system

6.3.1 Parameters

Overview

The drive is adapted to the relevant drive task by means of parameters. Each parameter is identified by a unique parameter number and by specific attributes (e.g. read, write, BICO attribute, group attribute, and so on).

The parameters can be accessed via the following means:

- PC with the "STARTER" commissioning tool via PROFIBUS
- The user-friendly AOP30 Operator Panel

Parameter types

The following adjustable and display parameters are available:

- Adjustable parameters (write/read)

These parameters have a direct impact on the behavior of a function.

Example: Ramp-up and ramp-down time of a ramp-function generator

- Display parameters (read-only)

These parameters are used to display internal variables.

Example: current motor current

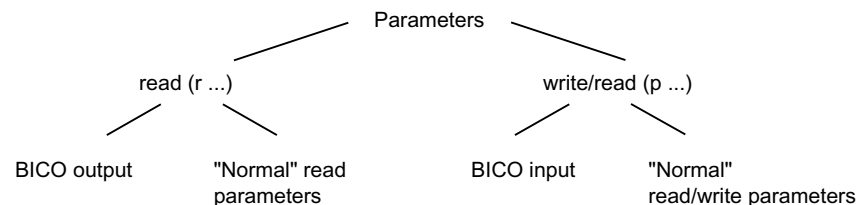


Figure 6-1 Parameter types

All these drive parameters can be read and changed via PROFIBUS using the mechanisms defined in the PROFIdrive profile.

Parameter categories

The parameters for the individual drive objects (see "Drive objects") are categorized according to data sets as follows (see "Operation/data sets"):

- Data-set-independent parameters
These parameters exist only once per drive object.
- Data-set-dependent parameters
These parameters can exist several times for each drive object and can be addressed via the parameter index for reading and writing. A distinction is made between various types of data set:
 - CDS: Command data set
By parameterizing several command data sets and switching between them, the drive can be operated with different pre-configured signal sources.
 - DDS: Drive data set
The drive data set contains the parameters for switching between different drive control configurations.

The CDS and DDS can be switched over during normal operation. Further types of data set also exist, however these can only be activated indirectly by means of a DDS changeover.

- EDS: encoder data set
- MDS: Motor data set

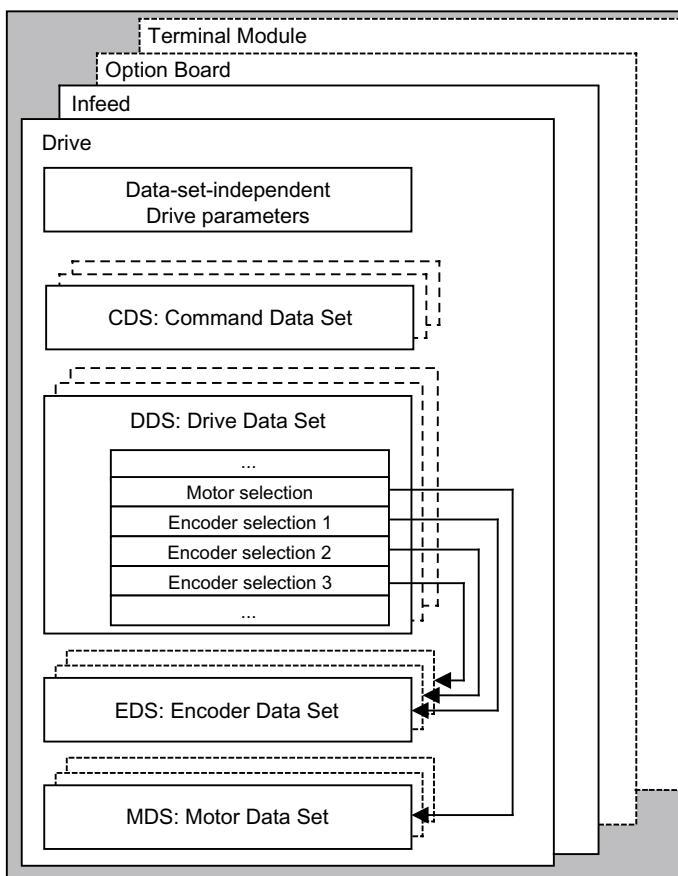


Figure 6-2 Parameter categories

6.3.2 Drive objects

A drive object is a self-contained software function with its own parameters and, if necessary, its own faults and alarms. Drive objects can be provided as standard (e.g. I/O evaluation), or you can add single (e.g. option board) or multiple objects (e.g. drive control).

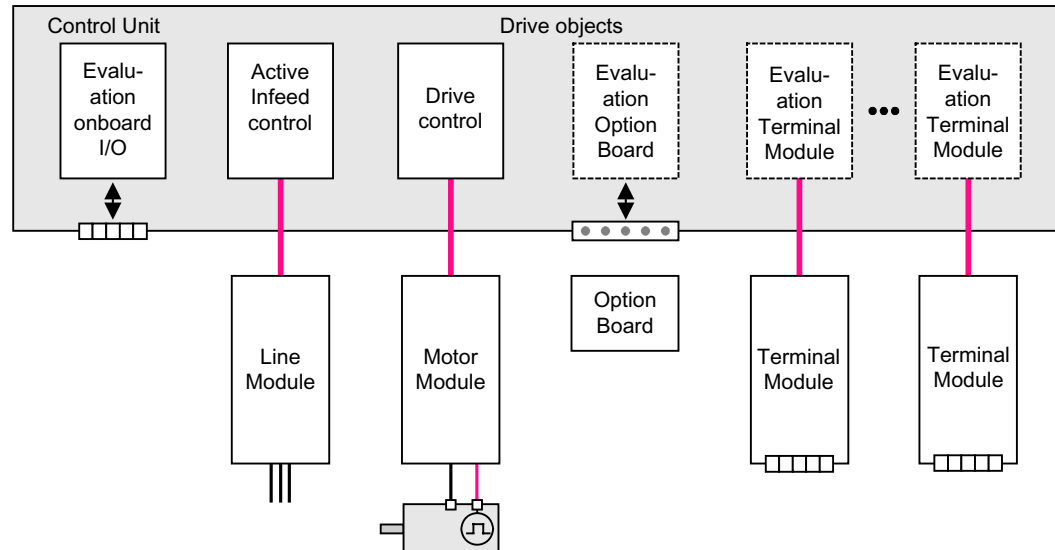


Figure 6-3 Drive objects

Standard drive objects

- **Infeed:** Infeed control for Active Line Module
If an Active Line Module is used for the infeed in a drive system, open-loop/closed-loop control is implemented on the Control Unit within a corresponding drive object.
- **Drive control**
Drive control handles closed-loop control of the motor. 1 Motor Module and at least 1 motor and up to 3 sensors are assigned to the drive control.
- **Control Unit, inputs/outputs**
The inputs/outputs on the Control Unit are evaluated within a drive object.

Optionally installed drive objects

- **Option board evaluation**
A further drive object handles evaluation of an installed option board. The specific method of operation depends on the type of option board installed.
- **Terminal Module evaluation**
A separate drive object handles evaluation of the respective optional Terminal Modules.

Properties of a drive object

- Separate parameter space
- Separate window in STARTER
- Separate fault/alarm system (for CU, VECTOR, A_INF)
- Separate PROFIdrive telegram for process data (for CU, VECTOR, A_INF)

Configuring drive objects

When you commission the system for the first time using the STARTER tool, you will use configuration parameters to set up the software-based "drive objects" which are processed on the Control Unit. Various drive objects can be created within a Control Unit.

The drive objects are configurable function blocks and are used to execute specific drive functions.

If you need to configure additional drive objects or delete existing ones after initial commissioning, the drive system must be switched to configuration mode.

The parameters of a drive object cannot be accessed until the drive object has been configured and you have switched from configuration mode to parameterization mode.

Note

Each installed drive object is allocated a number between 0 and 63 during initial commissioning for unique identification.

Parameters

- p0101 Drive object numbers
- r0102 Number of drive objects
- p0107 Drive object type
- p0108 Drive object configuration

6.3.3 Data sets

Description

For many applications, it is beneficial if more than one parameter can be changed simultaneously by means of **one** external signal during operation/when the system is ready for operation.

This can be carried out using indexed parameters, whereby the parameters are grouped together in a data set according to their functionality and indexed. Indexing allows several different settings, which can be activated by switching the data set, to be defined in each parameter.

Note

The command and drive data sets can be copied in STARTER (Drive -> Configuration -> "Command data sets" or "Drive data sets" tab).

The displayed command and drive data sets can be selected in the associated STARTER screen forms..

CDS: Command data set

The BICO parameters (binector and connector inputs) are grouped together in a command data set. These parameters are used to interconnect the signal sources of a drive (see "Operation/BICO technology: Interconnecting signals").

By parameterizing several command data sets and switching between them, the drive can be operated with different pre-configured signal sources.

A command data set contains the following (examples):

- Binector inputs for control commands (digital signals)
 - ON/OFF, enable signals (p0844, etc.)
 - Jog (p1055, etc.)
- Connector inputs for setpoints (analog signals)
 - Voltage setpoint for V/f control (p1330)
 - Torque limits and scaling factors (p1522, p1523, p1528, p1529)

In the factory setting, two command data sets are available; this number can be increased to a maximum of four using p0170 (number of command data sets (CDS)).

The following parameters are available for selecting command data sets and for displaying the currently selected command data set:

Table 6-1 Command data set: selection and display

CDS	Select bit 1 p0811	Select bit 0 p0810	Display	
			selected (r0836)	active (r0050)
0	0	0	0	0
1	0	1	1	1
2	1	0	2	2
3	1	1	3	3

If a command data set, which does not exist, is selected, the current data set remains active.

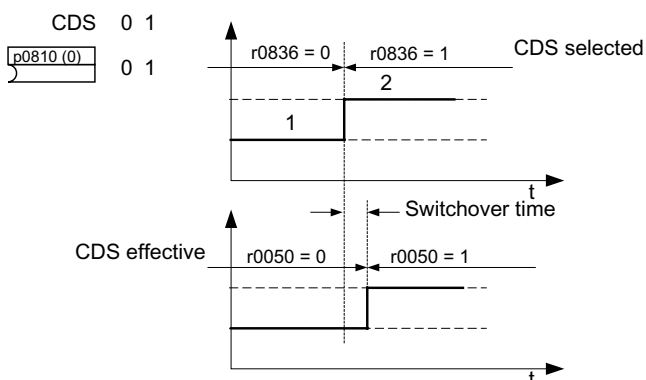


Figure 6-4 Example: Switching between command data set 0 and 1

DDS: Drive data set

A drive data set contains various adjustable parameters that are relevant with respect to open and closed-loop drive control:

- Numbers of the assigned motor and encoder data sets:
 - p0186: Assigned motor data set (MDS)
 - p0187 to p0189: up to 3 assigned encoder data sets (EDS)
- Various control parameters, e.g.:
 - Fixed speed setpoints (p1001 to p1015)
 - Speed limits min./max. (p1080, p1082)
 - Characteristic data of ramp-function generator (p1120 ff)
 - Characteristic data of controller (p1240 ff)
 - ...

The parameters that are grouped together in the drive data set are identified in the SINAMICS parameter list by "Data set DDS" and are assigned an index [0..n].

It is possible to parameterize several drive data sets. You can switch easily between different drive configurations (control type, motor, encoder) by selecting the corresponding drive data set.

One drive object can manage up to 32 drive data sets. The number of drive data sets is configured with p0180.

Binector inputs p0820 to p0824 are used to select a drive data set. They represent the number of the drive data set (0 to 31) in binary format (where p0824 is the most significant bit).

- p0820 BI: Drive data set selection DDS, bit 0
- p0821 BI: Drive data set selection DDS, bit 1
- p0822 BI: Drive data set selection DDS, bit 2
- p0823 BI: Drive data set selection DDS, bit 3
- p0824 BI: Drive data set selection DDS, bit 4

Supplementary conditions and recommendations

- Recommendation for the number of DDS in a drive
The number of DDS in a drive should correspond with the number of changeover options; in other words
 $p0180 \text{ (DDS)} \geq p0130 \text{ (MDS)}$.
- Max. number of DDS for one drive object = 32 DDS

EDS: Encoder data set

An encoder data set contains various adjustable parameters describing the connected encoder for the purpose of configuring the drive.

- Adjustable parameters, e.g.:
 - Encoder interface component number (p0141)
 - Encoder component number (p0142)
 - Encoder type selection (p0400)

The parameters that are grouped together in the encoder data set are identified in the SINAMICS parameter list by "Data set EDS" and are assigned an index [0..n].

A separate encoder data set is required for each encoder controlled by the Control Unit. Up to 3 encoder data sets are assigned to a drive data set via parameters p0187, p0188, and p0189.

An encoder data set can only be changed using a DDS changeover.

Each encoder may only be assigned to one drive and within a drive must - in each drive data set - either always be encoder 1, always encoder 2 or always encoder 3.

One application for the EDS changeover would be a power component with which several motors are operated in turn. A contactor circuit is used to changeover between these motors. Each of the motors can be equipped with an encoder or be operated without an encoder. Each encoder must be connected to its own SMx.

If encoder 1 (p0187) is changed over via DDS, then an MDS must also be changed over.

One drive object can manage up to 16 encoder data sets. The number of encoder data sets configured is specified in p0140.

When a drive data set is selected, the assigned encoder data sets are selected automatically.

MDS: Motor data set

A motor data set contains various adjustable parameters describing the connected motor for the purpose of configuring the drive. It also contains certain display parameters with calculated data.

- Adjustable parameters, e.g.:
 - Motor component number (p0131)
 - Motor type selection (p0300)
 - Rated motor data (p0304 ff)
 - ...
- Display parameters, e.g.:
 - Calculated rated data (p0330 ff)
 - ...

The parameters that are grouped together in the motor data set are identified in the SINAMICS parameter list by "Data set MDS" and are assigned an index [0..n].

A separate motor data set is required for each motor that is controlled by the Control Unit via a Motor Module. The motor data set is assigned to a drive data set via parameter p0186.

A motor data set can only be changed using a DDS changeover.

The motor data set changeover is, for example, used for:

- Changing over between different motors
- Changing over between different windings in a motor (e.g. star-delta changeover)
- Motor data adaptation

If several motors are operated alternately on one Motor Module, a corresponding number of drive data sets must be created. See "Functions / Drive functions" for additional information and instructions on changing over motors.

One drive object can manage up to 16 motor data sets. The number of motor data sets in p0130 may not exceed the number of drive data sets in p0180.

Example of data set assignment

Table 6-2 Example, data set assignment

DDS	Motor (p0186)	Encoder 1 (p0187)	Encoder 2 (p0188)	Encoder 3 (p0189)
DDS 0	MDS 0	EDS 0	EDS 1	EDS 2
DDS 1	MDS 0	EDS 0	EDS 3	--
DDS 2	MDS 0	EDS 0	EDS 4	EDS 5
DDS 3	MDS 1	EDS 0	--	--

Copying the command data set (CDS)

Set parameter p0809 as follows:

1. p0809[0] = number of the command data set to be copied (source)
2. p0809[1] = number of the command data to which the data is to be copied (target)
3. p0809[2] = 1

Start copying.

Copying is finished when p0809[2] = 0.

Copying the drive data set (DDS)

Set parameter p0819 as follows:

1. p0819[0] = Number of the drive data set to be copied (source)
2. p0819[1] = Number of the drive data set to which the data is to be copied (target)
3. p0819[2] = 1

Start copying.

Copying is finished when p0819[2] = 0.

Copy motor data set (MDS)

Set parameter p0139 as follows:

1. p0139[0] = Number of the motor data set that is to be copied (source)
2. p0139[1] = Number of the motor data set which should be copied into (target)
3. p0139[2] = 1

Start copying.

Copying has been completed, if p0139[2] = 0.

Function diagram

FP 8560	Command data sets (CDS)
FP 8565	Drive data set (DDS)
FP 8570	Encoder data set (EDS)
FP 8575	Motor data sets (MDS)

Parameter

- p0120 Power Module data sets (PDS) number
- p0130 Motor data sets (MDS) number
- p0139[0...2] Copy motor data set (MDS)
- p0140 Encoder data sets (EDS) number
- p0170 Command data set (CDS) number
- p0180 Drive data set (DDS) number
- p0186 Assigned motor data set (MDS)
- p0187[0...n] Encoder 1 encoder data set number
- p0188[0...n] Encoder 2 encoder data set number
- p0189[0...n] Encoder 3 encoder data set number
- p0809 Copy command data set CDS
- p0810 BI: Command data set selection CDS bit 0
- p0811 BI: Command data set selection CDS bit 1
- p0819[0...2] Copy drive data set DDS
- p0820 BI: Drive data set selection, bit 0
- p0821 BI: Drive data set selection, bit 1
- p0822 BI: Drive data set selection, bit 2
- p0823 BI: Drive data set selection, bit 3
- p0824 BI: Drive data set selection, bit 4

6.3.4 BICO technology: Interconnecting signals

Description

Every drive contains a large number of interconnectable input and output variables and internal control variables.

BICO technology (Binector Connector Technology) allows the drive to be adapted to a wide variety of conditions.

Digital signals, which can be connected freely by means of BICO parameters, are identified by the prefix BI, BO, CI or CO in their parameter name. These parameters are identified accordingly in the parameter list or in the function diagrams.

Note



The STARTER parameterization and commissioning tool is recommended when using BICO technology.

Binectors, BI: binector input, BO: Binector output

A binector is a digital (binary) signal without a unit which can assume the value 0 or 1.

Binectors are subdivided into binector inputs (signal sink) and binector outputs (signal source).

Table 6- 3 Binectors



Abbreviation and symbol	Name	Description
BI 	Binector input Binector Input (signal sink)	Can be interconnected to a binector output as source. The number of the binector output must be entered as a parameter value.
BO 	Binector output Binector output (signal source)	Can be used as a source for a binector input.

Connectors, CI: connector input, CO: Connector output

A connector is a digital signal e.g. in 32-bit format. It can be used to emulate words (16 bits), double words (32 bits) or analog signals. Connectors are subdivided into connector inputs (signal sink) and connector outputs (signal source).

The options for interconnecting connectors are restricted to ensure that performance is not adversely affected.

Table 6- 4 Connectors

Abbreviation and symbol	Name	Description
CI 	Connector input Connector input (signal sink)	Can be interconnected to a connector output as source. The number of the connector output must be entered as a parameter value.
CO 	Connector output Connector output (signal source)	Can be used as a source for a connector input.

Interconnecting signals using BICO technology

To interconnect two signals, a BICO input parameter (signal sink) must be assigned to the desired BICO output parameter (signal source).

The following information is required in order to connect a binector/connector input to a binector/connector output:

- Binectors: Parameter number, bit number, and drive object ID
- Connectors with no index: Parameter number and drive object ID
- Connectors with index: Parameter number, index, and drive object ID

6.3 Basic information about the drive system

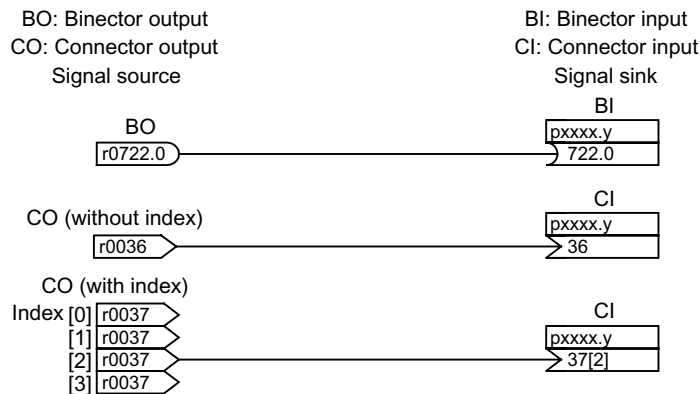


Figure 6-5 Interconnecting signals using BICO technology

Note

A connector input (CI) cannot be interconnected with any connector output (CO, signal source). The same applies to the binector input (BI) and binector output (BO).

"Data type" in the parameter list provides information about the data type of the parameter and the data type of the BICO parameter for each CI und BI parameter.

For CO and BO parameters, only the data type of the BICO parameter is given.

Notation:

- Data type BICO input: Data type parameter / Data type BICO parameter
Example: Unsigned32 / Integer16
- Data type BICO output: Data type BICO parameter
Example: FloatingPoint32

The possible interconnections between BICO input (signal sink) and BICO output (signal source) are described in the List Manual in the table "Possible combinations for BICO interconnections" in the section "Explanations on the parameter list".

The BICO parameter interconnection can be implemented in different data sets (CDS, DDS, MDS, etc.). The different interconnections in the data sets are activated by switching the data sets. Interconnections across drive objects are also possible.

Internal encoding of the binector/connector output parameters

The internal codes are needed, for example, to write BICO input parameters via PROFIdrive.

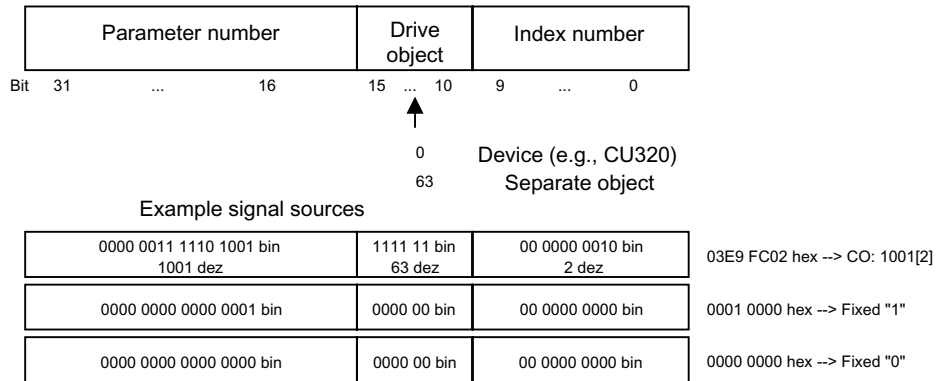


Figure 6-6 Internal encoding of the binector/connector output parameters

Example 1: interconnecting digital signals

Suppose you want to operate a drive via terminals DI 0 and DI 1 on the Control Unit using jog 1 and jog 2.

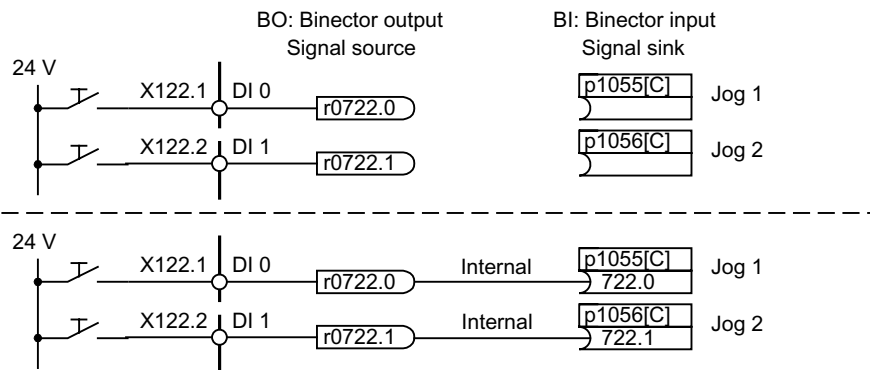


Figure 6-7 Interconnection of digital signals (example)

Example 2: connection of OC/OFF3 to several drives

The OFF3 signal is to be connected to two drives via terminal DI 2 on the Control Unit.

Each drive has a binector input 1. OFF3 and 2. OFF3. The two signals are processed via an AND gate to STW1.2 (OFF3).

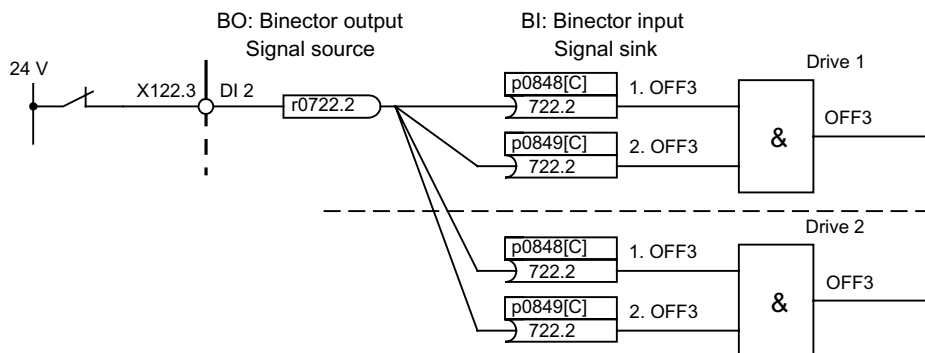


Figure 6-8 Connection of OFF3 to several drives (example)

BICO interconnections to other drives

The following parameters are available for BICO interconnections to other drives:

- r9490 Number of BICO interconnections to other drives
- r9491[0...15] BI/CI of BICO interconnections to other drives
- r9492[0...15] BO/CO of BICO interconnections to other drives
- p9493[0...15] Reset BICO interconnections to other drives

Binector-connector converters and connector-binector converters

Binector-connector converter

- Several digital signals are converted to a 32-bit integer double word or to a 16-bit integer word.
- p2080[0...15] BI: PROFIdrive PZD send bit-serial

Connector-binector converter

- A 32-bit integer double word or a 16-bit integer word is converted to individual digital signals.
- p2099[0...1] CI PROFIdrive PZD selection receive bit-serial

Fixed values for interconnection using BICO technology

The following connector outputs are available for interconnecting any fixed value settings:

- p2900[0...n] CO: Fixed value_%_1
- p2901[0...n] CO: Fixed value_%_2
- p2930[0...n] CO: Fixed Value_M_1

Example:

These parameters can be used to interconnect the scaling factor for the main setpoint or to interconnect an additional torque.

6.4 Command sources

6.4.1 "PROFIdrive" default setting

Requirements

The "PROFIdrive" default setting was chosen during commissioning:

- STARTER: "PROFIdrive"
- AOP30: "5: PROFIdrive"

Command sources

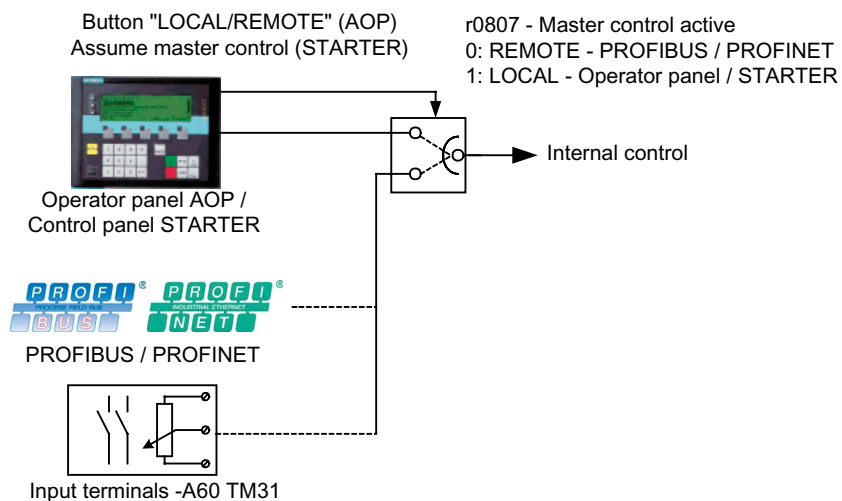


Figure 6-9 Command sources - AOP30 ↔ PROFIdrive

Priority

The command source priorities are shown in the diagram "Command sources - AOP30↔PROFIdrive".

Note

The EMERGENCY STOP and motor protection signals are always active (regardless of the command source).

All of the supplementary setpoints are deactivated for LOCAL master control.

TM31 terminal assignment with "PROFdrive" default setting

When you choose the "PROFdrive" default setting, use the following terminal assignment for TM31:

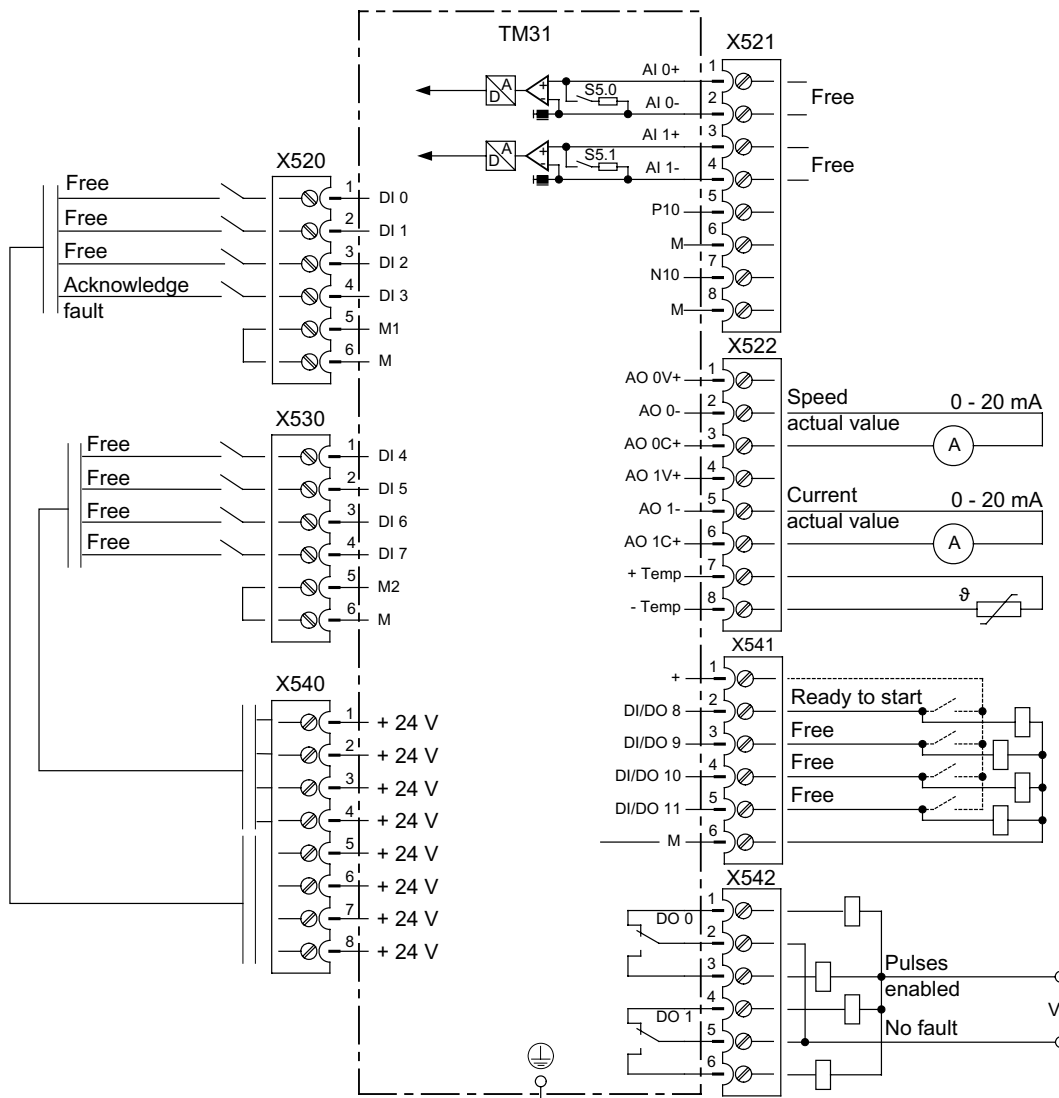


Figure 6-10 TM31 terminal assignment with "PROFdrive" default setting

Control word 1

The bit assignment for control word 1 is described in "Description of the control words and setpoints".

Status word 1

The bit assignment for status word 1 is described in "Description of the status words and actual values".

Switching the command source

The command source can be switched using the LOCAL/REMOTE key on the AOP30.

6.4.2 "TM31 terminals" default setting

Prerequisites

The "TM31 Terminals" default setting was chosen during commissioning:

- STARTER: "TM31 Terminals"
- AOP30: "6: TM31 terminals"

Command sources

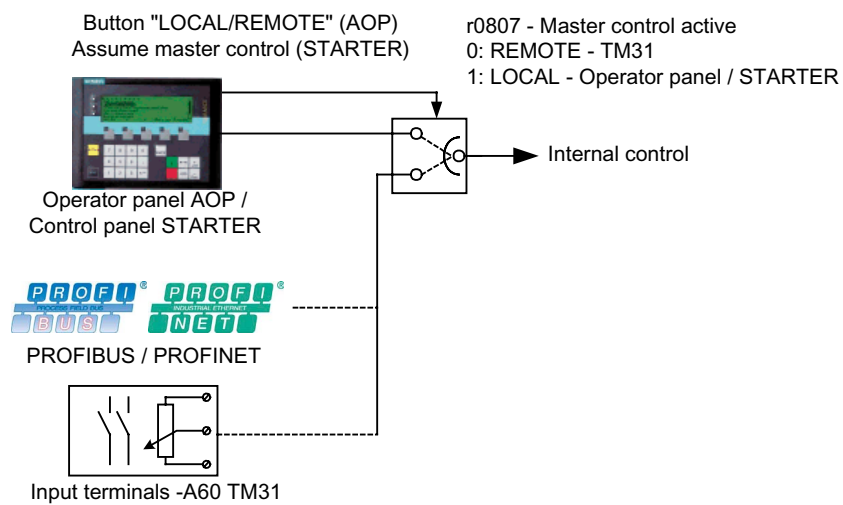


Figure 6-11 Command sources - AOP30 ↔ terminal TM31

Priority

The priority of the command sources is shown in the diagram "Command sources - AOP30 ↔ terminal TM31".

Note

The emergency OFF and motor protection signals are always active (regardless of the command source).

For LOCAL master control, all of the supplementary setpoints are de-activated.

TM31 terminal assignment with "TM31 Terminals" default setting

When you choose the "TM31 Terminals" default setting, the terminal assignment for TM31 is as follows:

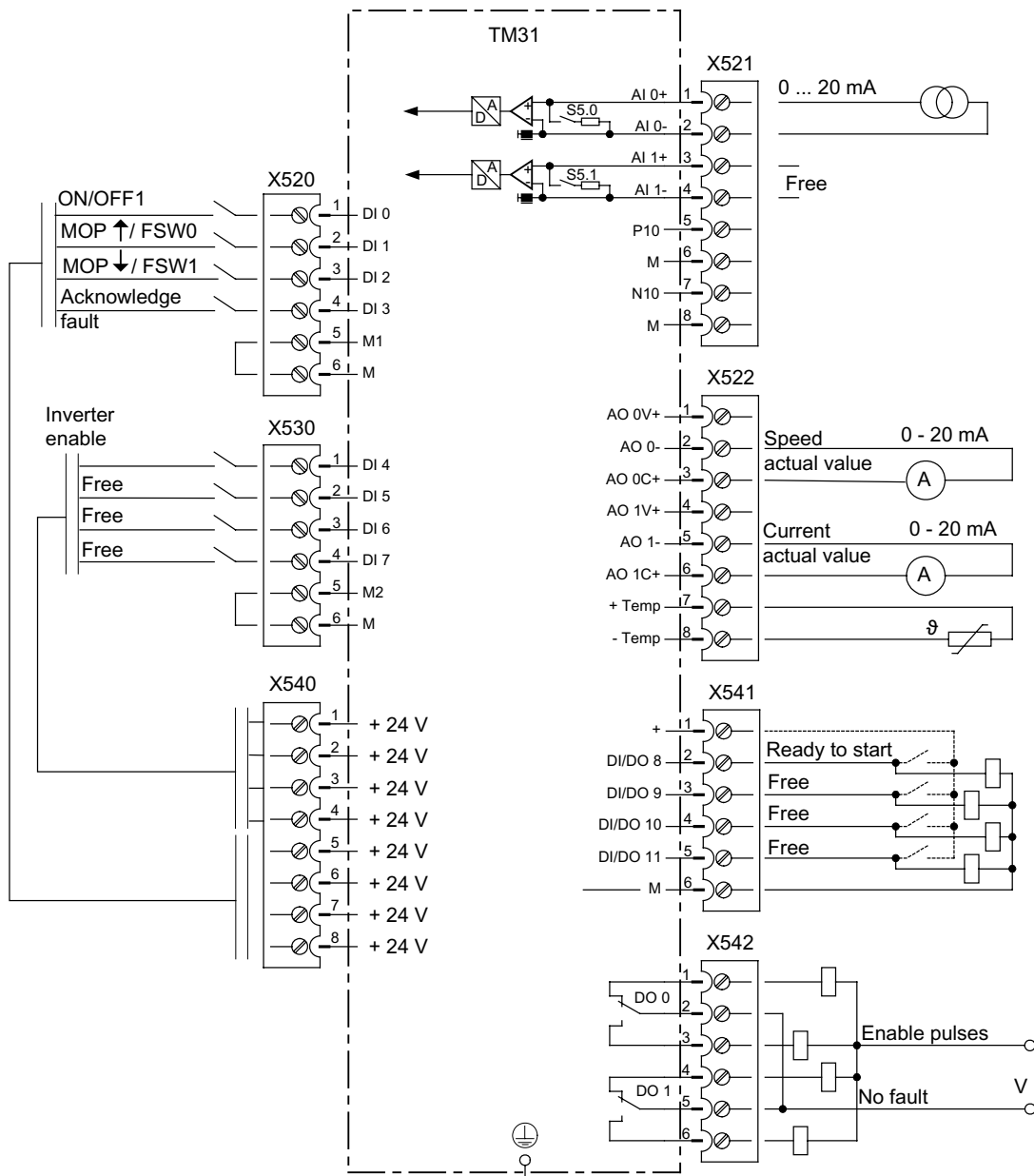


Figure 6-12 TM31 terminal assignment with "TM31 Terminals" default setting

Switching the command source

The command source can be switched using the LOCAL/REMOTE key on the AOP30.

6.4.3 "NAMUR" default setting

Prerequisites

The NAMUR terminal block (option B00) is installed in the cabinet unit.
The "NAMUR" default setting was chosen during commissioning:

- STARTER: "NAMUR"
- AOP30: "7: NAMUR"

Command sources

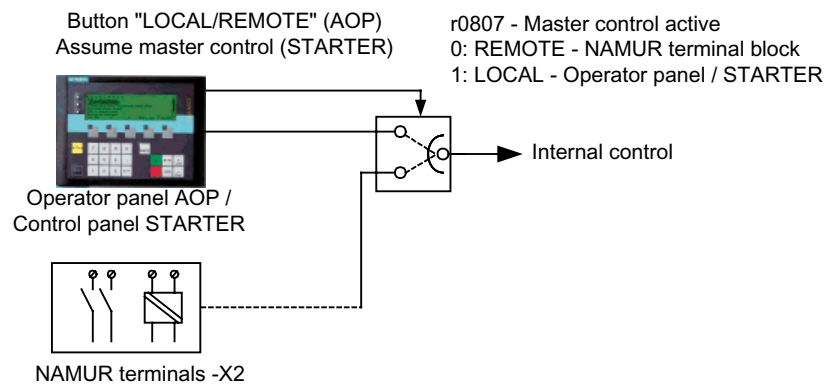


Figure 6-13 Command sources - AOP30↔NAMUR terminal block

Priority

The priority of the command sources is shown in the diagram "Command sources - AOP30↔NAMUR terminal block".

Note

The EMERGENCY STOP and motor protection signals are always active (regardless of the command source).

For LOCAL master control, all of the supplementary setpoints are deactivated.

Terminal Assignment with the "NAMUR" Default Setting

When you choose the "NAMUR" default setting, the terminal assignment is as follows (as with option B00):

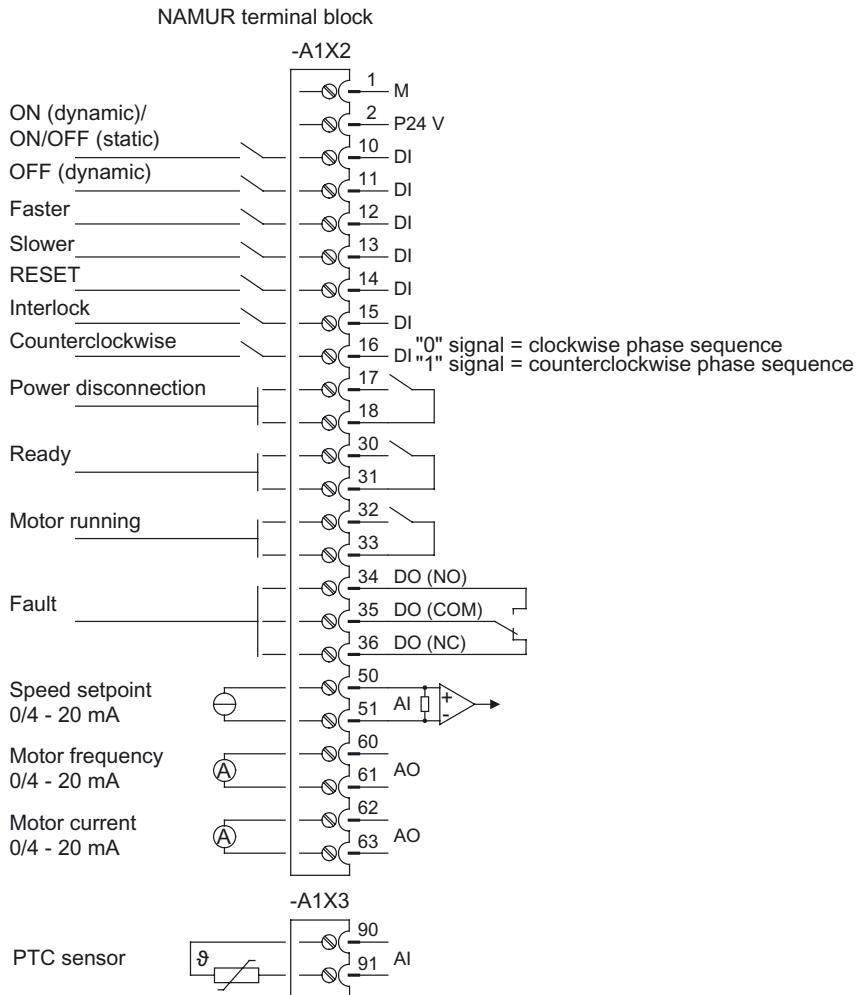


Figure 6-14 Terminal assignment with "NAMUR terminal block" default setting

Switching the command source

The command source can be switched using the LOCAL/REMOTE key on the AOP30.

6.4.4 "PROFIdrive NAMUR" default setting

Prerequisites

The NAMUR terminal block (option B00) is installed in the cabinet unit.
The "PROFIdrive" default setting was chosen during commissioning:

- STARTER: "PROFIdrive Namur"
- AOP30: "10: PROFIdrive Namur"

Command sources

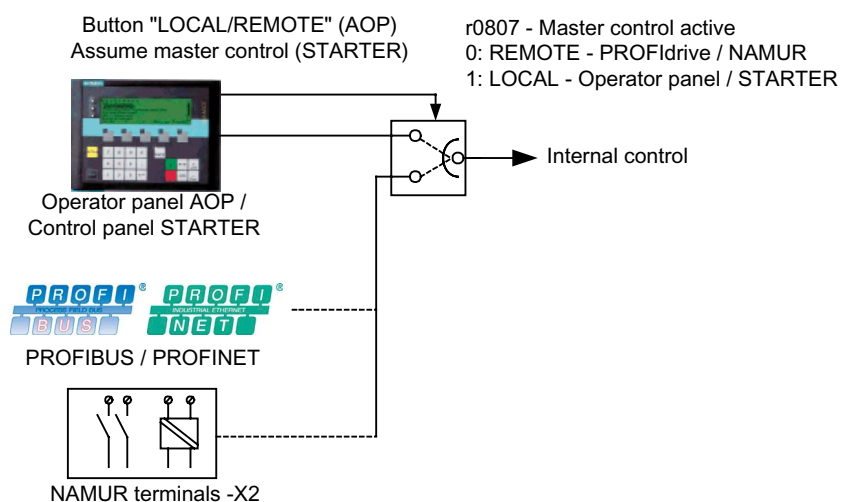


Figure 6-15 Command sources - AOP30 ↔ PROFIdrive NAMUR

Priority

The priority of the command sources is shown in the diagram "Command sources - AOP30 ↔ PROFIdrive NAMUR".

Note

The EMERGENCY STOP and motor protection signals are always active (regardless of the command source).

All of the supplementary setpoints are deactivated for LOCAL master control.

Terminal assignment for the "PROFIdrive NAMUR" default setting

When you choose the "PROFIdrive NAMUR" default setting, the terminal assignment is as follows (as with option B00):

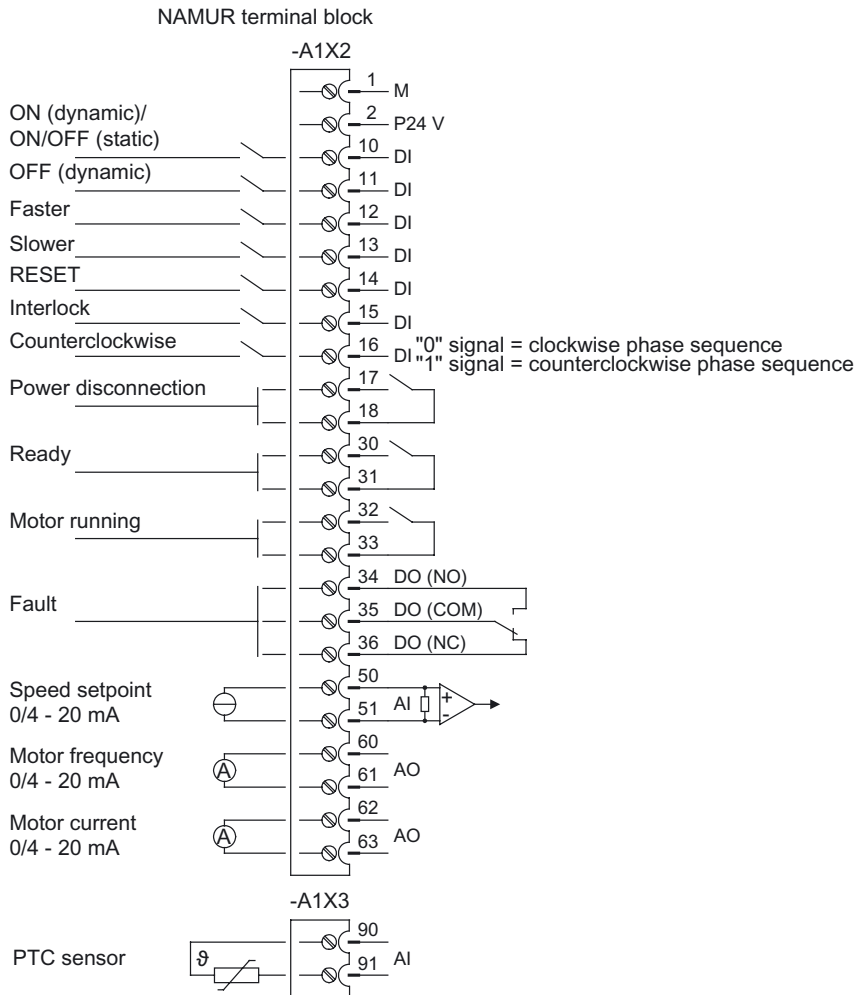


Figure 6-16 Terminal assignment for the "PROFIdrive NAMUR" default setting

Control word 1

The bit assignment for control word 1 is described in "Description of the control words and setpoints".

Status word 1

The bit assignment for status word 1 is described in "Description of the status words and actual values".

Switching the command source

The command source can be switched using the LOCAL/REMOTE key on the AOP30.

6.5 Setpoint sources

6.5.1 Analog inputs

Description

The customer terminal block TM31 features two analog inputs for specifying setpoints for current or voltage signals.

In the factory setting, analog input 0 (terminal X521:1/2) is used as a current input in the range 0 to 20 mA.

Requirement

The default setting for analog inputs was chosen during commissioning:

- STARTER: "TM31 Terminals"
- AOP30: "2: TM31 terminals"

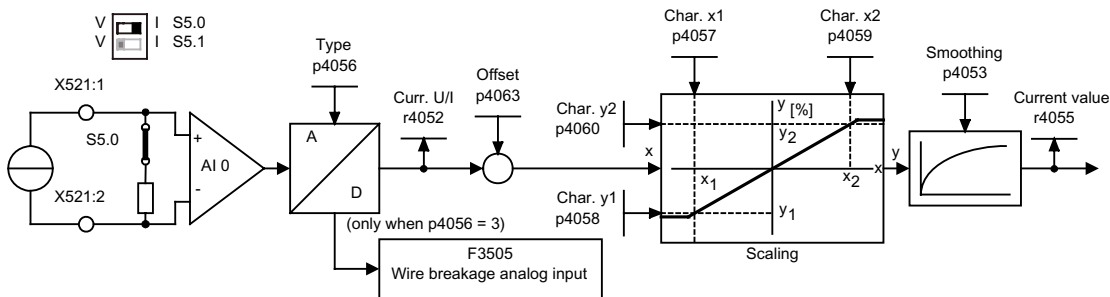


Figure 6-17 Signal flow diagram: analog input 0

Function diagram

- | | |
|---------|------------------------------|
| FP 9566 | TM31 – analog input 0 (AI 0) |
| FP 9568 | TM31 – analog input 1 (AI 1) |

Parameter

- r4052 Actual input voltage/current
- p4053 Analog inputs smoothing time constant
- r4055 Analog inputs, actual input value in percent
- p4056 Analog inputs type
- p4057 Analog inputs, characteristic value x1

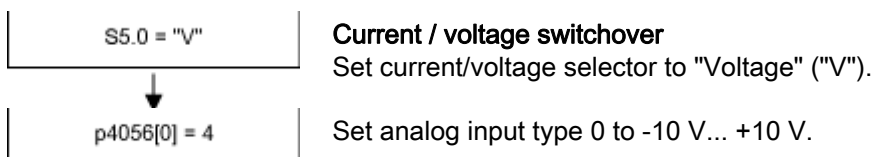
- p4058 Analog inputs, characteristic value y1
- p4059 Analog inputs, characteristic value x2
- p4060 Analog inputs, characteristic value y2
- p4063 Analog inputs offset

Note

In the factory setting and after basic commissioning, an input current of 20 mA is equal to the main setpoint 100% reference speed (p2000), which has been set to the maximum speed (p1082).

Example: Changing Analog Input 0 from Current to Voltage Input –10 to +10 V

Table 6- 5 Example: setting analog input 0



Note

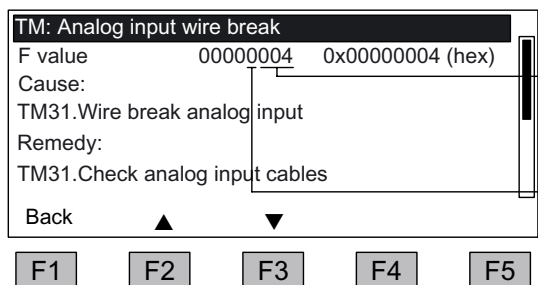
The new analog input must then be stored on the CompactFlash card so that it is protected in the event of a power failure.

F3505 – Fault: "Analog input, wire breakage"

The fault is triggered when analog input type (p4056) is set to 3 (4 ... 20 mA with open-circuit monitoring) and the input current of 2 mA has been undershot.

The fault value can be used to determine the analog input in question.

Table 6- 6 Fault screen



Component number
 4: module -A60
 5: module -A61 (optional)
 0: Analog input 0: -X521:1/2
 1: Analog input 1: -X521:3/4

6.5.2 Motorized potentiometer

Description

The digital motorized potentiometer enables you to set speeds remotely using switching signals (+/- keys). It is activated via terminals or PROFIBUS. As long as a logical 1 is present at signal input "MOP raise" (setpoint higher), the internal numerator integrates the setpoint. You can set the integration time (time taken for the setpoint to increase) using parameter p1047. In the same way, you can decrease the setpoint using signal input "MOP lower". The deceleration ramp can be set using parameter p1048. Configuration parameter p1030.0 = 1 (default setting = 0) is used to activate that the actual motorized potentiometer is saved in a non-volatile fashion when powering-down the drive unit. When powering-up the drive unit, the starting (initial) value of the motorized potentiometer is set to the last, actual value that was present when the drive unit was powered-down.

Prerequisites

The default setting for the motorized potentiometer was chosen during commissioning:

- STARTER: "Motorized potentiometer"
- AOP30: "3: Motorized potentiometer"

Signal flow diagram

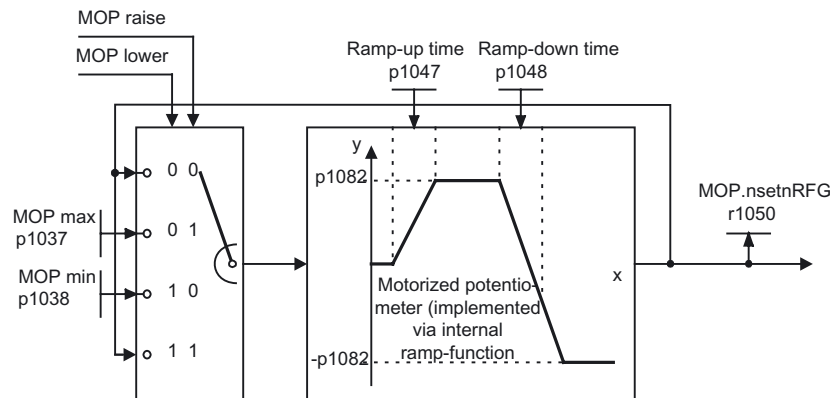


Figure 6-18 Signal flow diagram: Motorized potentiometer

Function diagram

FD 3020 Motorized potentiometer

Parameters

- p1030 Motorized potentiometer, configuration
- p1037 Motorized potentiometer, maximum speed
- p1038 Motorized potentiometer, minimum speed
- p1047 Motorized potentiometer, ramp-up time
- p1048 Motorized potentiometer, ramp-down time
- r1050 Motorized potentiometer, setpoint after the ramp-function generator

6.5.3 Fixed speed setpoints

Description

A total of 15 variable fixed speed setpoints are available. The default setting specified for the setpoint sources during commissioning via STARTER or the operating panel makes 3 fixed speed setpoints available. They can be selected via terminals or PROFIBUS.

Requirement

The default setting for the fixed speed setpoints was chosen during commissioning:

- STARTER: "Fixed setpoint"
- AOP30: "4: Fixed setpoint"

Signal flow diagram

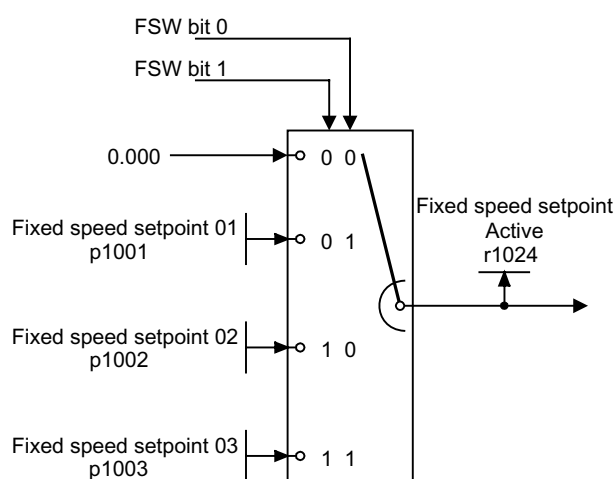


Figure 6-19 Signal flow diagram: Fixed speed setpoints

Function diagram

FP 3010 Fixed speed setpoints

Parameter

- p1001 Fixed speed setpoint 01
- p1002 Fixed speed setpoint 02
- p1003 Fixed speed setpoint 03
- r1024 Fixed speed setpoint effective

Note

Other fixed speed setpoints are available using p1004 to p1015. They can be selected using p1020 to p1023.

6.6 PROFIBUS

6.6.1 PROFIBUS connection

PROFIBUS Connection Position, Address Switch, and Diagnostic LED

The PROFIBUS connection, address switch, and diagnostics LED are located on the Control Unit CU320.

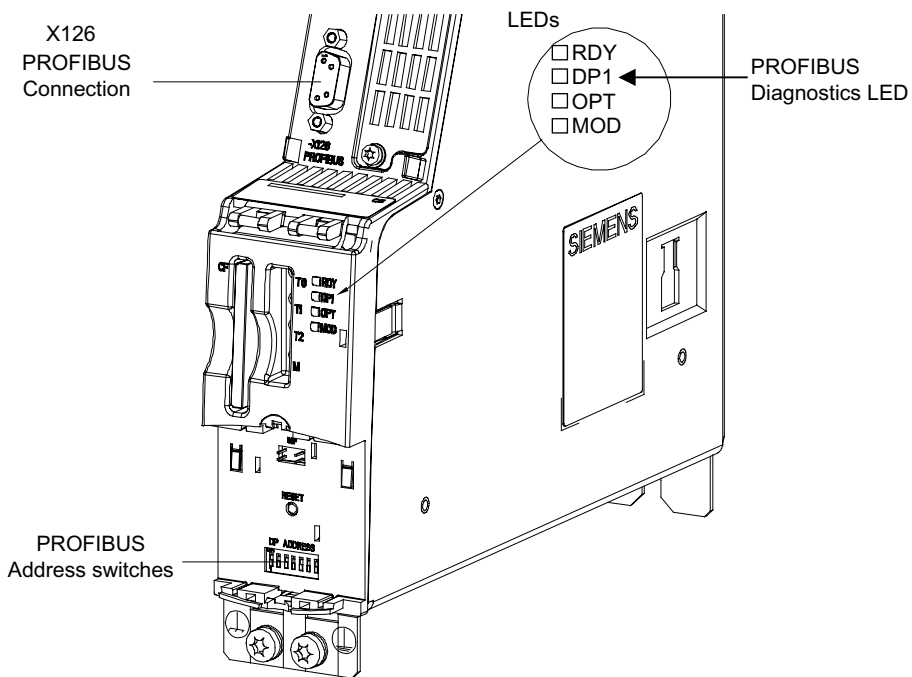
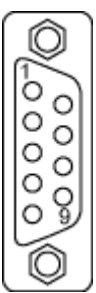


Figure 6-20 View of the Control Unit with PROFIBUS interface

PROFIBUS link

The PROFIBUS link is connected by means of a 9-pin SUB D socket (X126). The connections are electrically isolated.

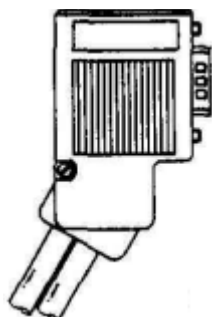
Table 6- 7 X126 - PROFIBUS connection

	Pin	Signal name	Meaning	Range
	1	SHIELD	Ground connection	
	2	M24_SERV	Power supply for teleservice, ground	0 V
	3	RxD/TxD-P	Receive / transmit data P (B/B')	RS485
	4	CNTR-P	Control signal	TTL
	5	DGND	PROFIBUS data reference potential (C/C')	
	6	VP	Supply voltage plus	5 V ± 10 %
	7	P24_SERV	Power supply for teleservice P, + (24 V)	24 V (20.4 V - 28.8 V)
	8	RxD/TxD-N	Receive / transmit data N (A/A')	RS485
	9	-	not assigned	

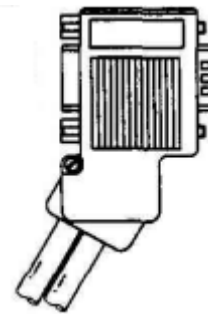
Connectors

The cables must be connected via PROFIBUS connectors as they contain the necessary terminating resistors.

The figure below shows suitable PROFIBUS connectors with/without a PG/PC connector.



PROFIBUS connector
without PG/PC connection
6ES7972-0BA41-0XA0



PROFIBUS connector
with PG/PC connection
6ES7972-0BB41-0XA0

Bus terminating resistor

The bus terminating resistor must be switched on or off depending on its position in the bus, otherwise the data will not be transmitted properly.

Principle: the terminating resistors must only be switched on at both ends of the bus line; the resistors must be switched off at all other connectors.

The cable shield must be connected at both ends over large-surface area contacts.

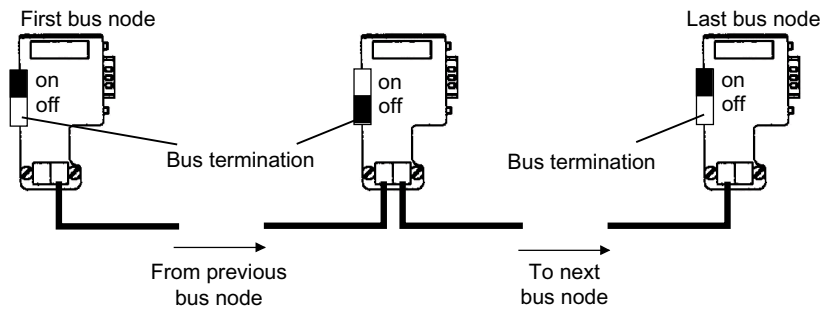


Figure 6-21 Position of the bus terminating resistors

Cable routing

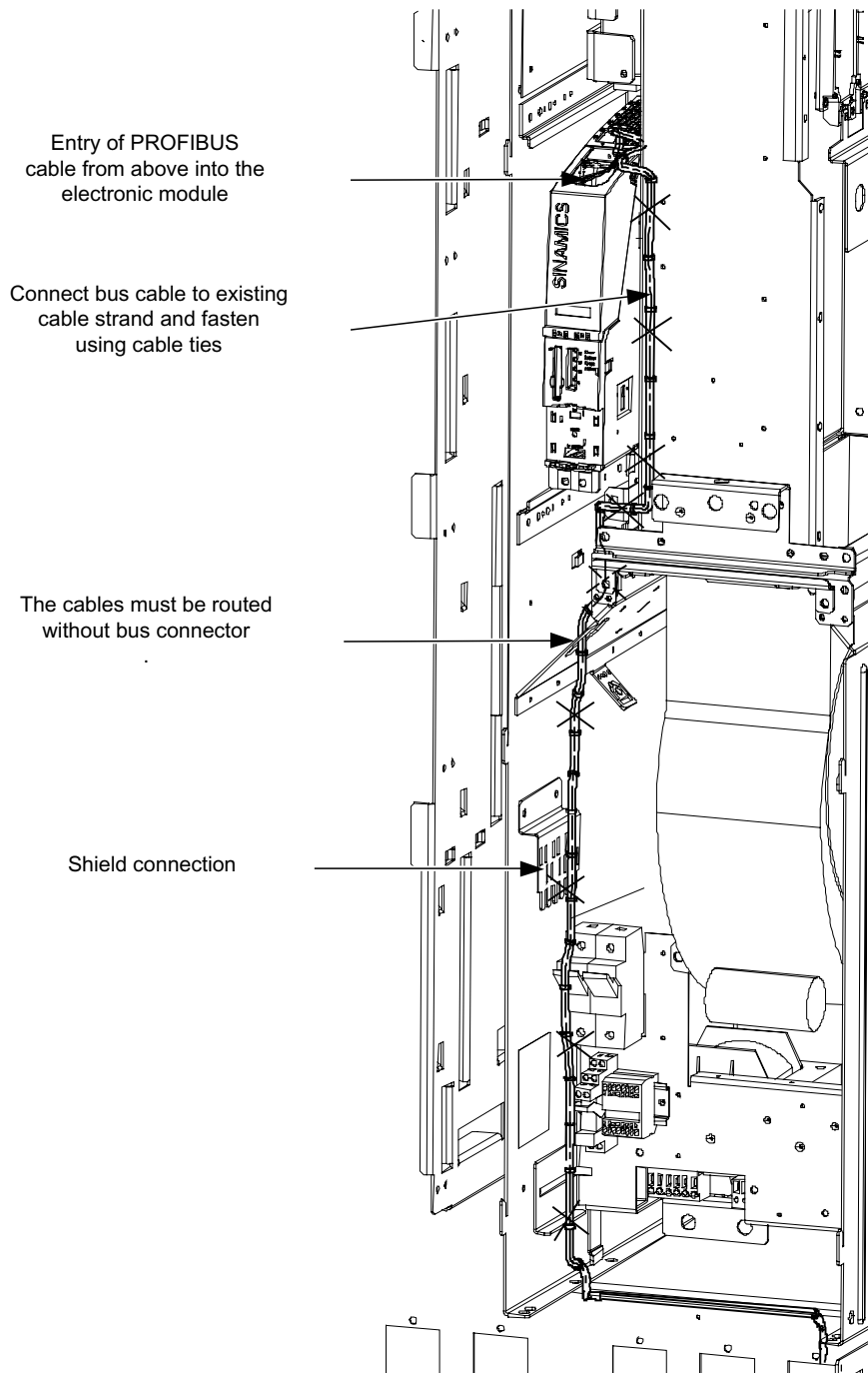


Figure 6-22 Cable routing

6.6.2 Control via PROFIBUS

More information on PROFIBUS programming

For more information about the PROFIBUS programming, refer to the section "PROFIBUS DP/PROFINET IO communication" in the documentation "SINAMICS S120 Function Manual".

"DP1 (PROFIBUS)" diagnostics LED

The PROFIBUS diagnostics LED is located on the front of the Control Unit CU320. Its statuses are described in the following table.

Table 6- 8 Description of the LEDs

Color	State	Description
----	OFF	Cyclic communication has not (yet) taken place.
Green	Steady light	PROFIBUS is ready for communication and cyclic communication is taking place.
Green	Flashing, 0.5 Hz	Full cyclic communication is not yet taking place. Possible causes: The master is not transmitting setpoints.
Red	Steady light	Cyclic communication has been interrupted.

Setting the PROFIBUS Address

Two methods are available for setting the PROFIBUS address:

- The address switches (DIP switches) on the front of the Control Unit behind the cover plate (see "PROFIBUS connection"). In this case, p0918 is read-only and shows the address setting.
A change to the switch only becomes effective after the Control Unit has been switched on.
- Entering parameter p0918 via the operator panel.
You can **only** do this if the address has been set to 0 or 127, that is, all switches from S1 to S7 are set to ON or OFF.
In this case, changes become effective immediately.

Table 6- 9 PROFIBUS address switches

Switch	Significance	Technical specifications
S1	2 ⁰ = 1	<div style="display: flex; align-items: center;"> <div style="margin-right: 10px;">Significance</div> <div style="display: flex; flex-direction: column; align-items: center;"> <div style="display: flex; justify-content: space-between; width: 100%;"> 2⁰2¹2²2³2⁴2⁵2⁶ </div> <div style="display: flex; justify-content: space-between; width: 100%;"> 1248163264 </div> <div style="display: flex; align-items: center; width: 100%;"> <div style="display: flex; justify-content: space-between; width: 100%;"> <div style="border: 1px solid black; width: 15px; height: 15px;"></div> <div style="border: 1px solid black; width: 15px; height: 15px;"></div> <div style="border: 1px solid black; width: 15px; height: 15px;"></div> <div style="border: 1px solid black; width: 15px; height: 15px;"></div> <div style="border: 1px solid black; width: 15px; height: 15px;"></div> <div style="border: 1px solid black; width: 15px; height: 15px;"></div> <div style="border: 1px solid black; width: 15px; height: 15px;"></div> </div> <div style="margin-left: 5px;">ON</div> </div> <div style="display: flex; align-items: center; width: 100%;"> <div style="display: flex; justify-content: space-between; width: 100%;"> <div style="border: 1px solid black; width: 15px; height: 15px; background-color: #cccccc;"></div> <div style="border: 1px solid black; width: 15px; height: 15px; background-color: #cccccc;"></div> <div style="border: 1px solid black; width: 15px; height: 15px; background-color: #cccccc;"></div> <div style="border: 1px solid black; width: 15px; height: 15px; background-color: #cccccc;"></div> <div style="border: 1px solid black; width: 15px; height: 15px; background-color: #cccccc;"></div> <div style="border: 1px solid black; width: 15px; height: 15px; background-color: #cccccc;"></div> <div style="border: 1px solid black; width: 15px; height: 15px; background-color: #cccccc;"></div> </div> <div style="margin-left: 5px;">OFF</div> </div> </div> <div style="display: flex; justify-content: space-between; width: 100%; margin-top: 5px;"> S1...S7 </div> </div> <div style="margin-top: 10px;"> <div style="display: flex; align-items: center;"> <div style="margin-right: 10px;">Example</div> <div style="display: flex; flex-direction: column; align-items: center;"> <div style="display: flex; justify-content: space-between; width: 100%;"> <div style="border: 1px solid black; width: 15px; height: 15px; background-color: #cccccc;"></div> <div style="border: 1px solid black; width: 15px; height: 15px;"></div> <div style="border: 1px solid black; width: 15px; height: 15px; background-color: #cccccc;"></div> <div style="border: 1px solid black; width: 15px; height: 15px;"></div> <div style="border: 1px solid black; width: 15px; height: 15px; background-color: #cccccc;"></div> <div style="border: 1px solid black; width: 15px; height: 15px;"></div> <div style="border: 1px solid black; width: 15px; height: 15px; background-color: #cccccc;"></div> </div> <div style="margin-left: 5px;">ON</div> </div> <div style="display: flex; align-items: center; width: 100%;"> <div style="display: flex; justify-content: space-between; width: 100%;"> <div style="border: 1px solid black; width: 15px; height: 15px;"></div> <div style="border: 1px solid black; width: 15px; height: 15px; background-color: #cccccc;"></div> <div style="border: 1px solid black; width: 15px; height: 15px;"></div> <div style="border: 1px solid black; width: 15px; height: 15px; background-color: #cccccc;"></div> <div style="border: 1px solid black; width: 15px; height: 15px;"></div> <div style="border: 1px solid black; width: 15px; height: 15px; background-color: #cccccc;"></div> <div style="border: 1px solid black; width: 15px; height: 15px;"></div> </div> <div style="margin-left: 5px;">OFF</div> </div> </div> <div style="display: flex; justify-content: space-between; width: 100%; margin-top: 5px;"> 1+4+32= 37 </div> </div>

Setting the PROFIBUS ID number

The PROFIBUS Ident Number (PNO-ID) can be set using p2042.

SINAMICS can be operated on PROFIBUS with various identities. This allows a PROFIBUS GSD that is independent of the device to be used (e.g. PROFIdrive VIK-NAMUR with Ident Number 3AA0 hex).

- 0: SINAMICS S/G
- 1: VIK-NAMUR

New settings do not become active until after POWER ON, reset, or download.

Note

The advantages of Totally Integrated Automation (TIA) can only be utilized when selecting "0".

6.6.3 Monitoring: Telegram failure

Description

Following a telegram failure and after a monitoring time has elapsed (t_{An}), bit r2043.0 is set to "1" and alarm A01920 is output. Binector output r2043.0 can be used for an emergency stop, for example.

Once a delay time (p2044) has elapsed, fault F01910 is output and fault reaction OFF3 (quick stop) is triggered. If no OFF response is to be triggered, the fault response can be reparameterized accordingly.

Fault F01910 can be acknowledged immediately. The drive can then be operated even without PROFIBUS.

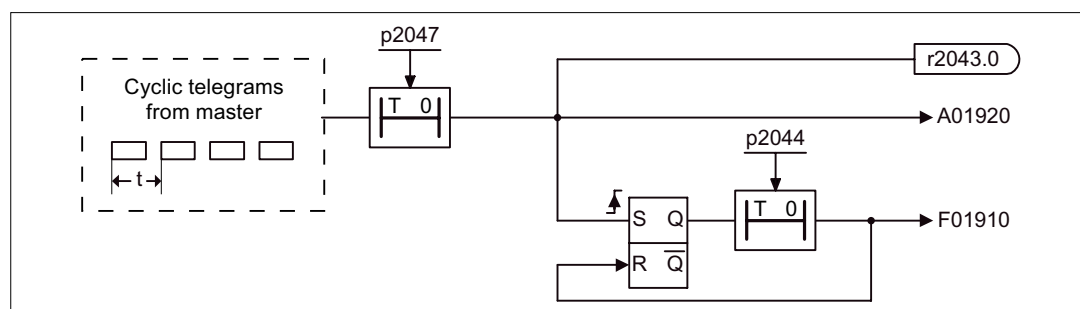


Figure 6-23 Monitoring: Telegram failure

6.6.4 Telegrams and process data

General information

Selecting a telegram via CU parameter p0922 determines which process data is transferred between the master and slave.

From the perspective of the slave (SINAMICS), the received process data comprises the receive words and the process data to be sent the send words.

The receive and send words comprise the following elements:

- Receive words: Control words and setpoints
- Send words: Status words and actual values

Default setting "Profidrive"

When the "Profidrive" default setting is chosen for command and setpoint selection (see "Command sources / "Profidrive" default settings"), "Free telegram" (p0922 = 999) is selected.

The receive message frame is parameterized as follows as a result of the default setting (plan 622):

STW1	NSOLL_A
------	---------

The send telegram is parameterized as follows (factory setting, plan 623):

ZSW1	NIST_GLATT	IAIST_GLATT	MIST_GLATT	PIST_GLATT	FAULT_CODE
------	------------	-------------	------------	------------	------------

You do not have to make any further settings in order to use these telegrams.

User-defined telegram selection

a. Standard telegrams

Standard telegrams are structured in accordance with PROFIdrive profile or internal company specifications. The internal process data links are established automatically in accordance with the telegram number setting in CU parameter p0922.

The following standard telegrams can be set via parameter p0922:

- p0922 = 1 -> Speed setpoint, 16 bit
- p0922 = 2 -> Speed setpoint, 32 bit
- p0922 = 3 -> Speed setpoint 32 bit with 1 position controller
- p0922 = 4 -> Speed setpoint 32 bit with 2 position controller
- p0922 = 7 -> Positioning telegram 7
- p0922 = 20 -> Speed setpoint, 16 bit VIK-NAMUR
- p0922 = 352 -> Speed setpoint, 16 PCS7

Depending on the setting in p0922, the interface mode of the control and status word is automatically set:

- p0922 = 1, 352, 999:
STW 1/ZSW 1: Interface Mode SINAMICS / MICROMASTER, p2038 = 0
- p0922 = 20:
STW 1/ZSW 1: Interface Mode PROFIdrive VIK-NAMUR, p2038 = 2

b. Manufacturer-specific telegrams

The manufacturer-specific telegrams are structured in accordance with internal company specifications. The internal process data links are set up automatically in accordance with the telegram number setting.

The following vendor-specific telegrams can be set via p0922:

- p0922 = 110 Positioning telegram 110
- p0922 = 220 Speed setpoint 32 bit, metal industry
- p0922 = 371 Infeed for metal industry

c. Free telegrams (p0922 = 999)

Send and receive telegrams can be configured as required by using BICO technology to interconnect the send and receive words. The default process data assigned under a) is retained during the changeover to p0922 = 999, although it can be changed or supplemented at any time.

To maintain compliance with the PROFIdrive profile, however, the following assignments should be retained:

- Interconnect PZD receive word 1 as control word 1 (STW 1)
- Interconnect PZD send word 1 as status word 1 (STW 1)

For more information about possible interconnections, see function diagrams FP2460 and FP2470 and the simplified diagrams 620 to 622.

Telegram interconnections

After changing p0922 = 999 (factory setting) to p0922 ≠ 999, the telegrams are interconnected and blocked automatically.

Note

Telegrams 20 and 352 are the exceptions. Here, the PZD06 in the send telegram and PZD03 to PZD06 in the receive telegram can be interconnected as required.

When you change p0922 ≠ 999 to p0922 = 999, the previous telegram interconnection is retained and can be changed.

Note

If p0922 = 999, a telegram can be selected in p2079. A telegram interconnection is automatically made and blocked. However, the telegram can also be extended.

This is an easy method of creating extended telegram interconnections on the basis of existing telegrams.

6.6.5 Structure of the telegrams

Table 6- 10 Structure of the telegrams

Telegr.	PZD 1	PZD 2	PZD 3	PZD 4	PZD 5	PZD 6	PZD 7	PZD 8	PZD 9	PZD 10
1	STW1	NSOLL_A								
	ZSW1	NIST_A								
2	STW1	NSOLL_B	STW2							
	ZSW1	NIST_B	ZSW2							
3	STW1	NSOLL_B	STW2		G1_STW					
	ZSW1	NIST_B	ZSW2		G1_ZSW	G1_XIST1	G1_XACT2			
4	STW1	NSOLL_B	STW2		G1_STW	G2_STW				
	ZSW1	NIST_B	ZSW2		G1_ZSW	Further assignment, see FP2420				
20	STW1	NSOLL_A								
	ZSW1	NIST_A_GLATT	IAIST_GLATT	MIST_GLATT	PIST_GLATT	MELD_NAMUR				
220	STW1_BM	NSOLL_B		STW2_BM	M_ADD	M_LIM	free	free	free	free
	ZSW1_BM	NIST_A	IAIST	MIST	WARN_CODE	FAULT_CODE	ZSW2_BM	free	free	free
352	STW1	NSOLL_A	PCS7_3	PCS7_4	PCS7_5	PCS7_6				
	ZSW1	NIST_A_GLATT	IAIST_GLATT	MIST_GLATT	WARN_CODE	FAULT_CODE				
370	E_STW_1									
	E_ZSW_1									
371	E_STW_1_BM	free	free	free	free					
	E_ZSW_1_BM	IAIST	WARN_CODE	FAULT_CODE	free	free	free	free		
999	STW1	free	free	free	free	free	free	free	free	free
	ZSW1	free	free	free	free	free	free	free	free	free

6.6.5.1 Overview of control words and setpoints

Table 6- 11 Overview of control words and setpoints

Abbreviation	Description	Parameter	Function diagram
STW1	Control word 1 (interface mode SINAMICS, p2038 = 0)	See table "Control word 1 (interface mode SINAMICS, p2038 = 0)"	FP2442
STW1	Control word 1 (interface mode VIK-NAMUR, p2038 = 2)	See table "Control word 1 (interface mode VIK-NAMUR, p2038 = 2)"	FP2441
STW1_BM	Control word 1, metal industry (interface mode SINAMICS, p2038 = 0)	See table "Control word 1, metal industry (interface mode SINAMICS, p2038 = 0)"	FP2425
STW2	Control word 2 (interface mode SINAMICS, p2038 = 0)	See table "Control word 2 (interface mode SINAMICS, p2038 = 0)"	FP2444
STW2_BM	Control word 2, metal industry (interface mode SINAMICS, p2038 = 0)	See table "Control word 2, metal industry (interface mode SINAMICS, p2038 = 0)"	FP2426
E_STW1	Control word 1 for infeeds	See table: "Control word 1 for infeeds"	FP2447
E_STW1_BM	Control word 1 for infeeds, metal industry	See table: "Control word 1 for infeeds, metal industry"	FP2427
NSOLL_A	Speed setpoint A (16-bit)	p1070	FP3030
NSOLL_B	Speed setpoint B (32-bit)	p1155	FP3080
PCS7_x	PCS7-specific setpoints		

6.6.5.2 Overview of status words and actual values

Table 6- 12 Overview of status words and actual values

Abbreviation	Description	Parameter	Function diagram
ZSW1	Status word 1 (interface mode SINAMICS, p2038 = 0)	See table "Status word 1 (interface mode SINAMICS, p2038 = 0)"	FP2452
ZSW1	Status word 1 (interface mode VIK-NAMUR, p2038 = 2)	See table "Status word 1 (interface mode VIK-NAMUR, p2038 = 2)"	FP2451
ZSW1_BM	Status word 1, metal industry (interface mode SINAMICS, p2038 = 0)	See table "Status word 1, metal industry (interface mode SINAMICS, p2038 = 0)"	FP2428
ZSW2	Status word 2 (interface mode SINAMICS, p2038 = 0)	See table "Status word 2 (interface mode SINAMICS, p2038 = 0)"	FP2454
ZSW2_BM	Status word 2, metal industry (interface mode SINAMICS, p2038 = 0)	See table "Status word 2, metal industry (interface mode SINAMICS, p2038 = 0)"	FP2429
E_ZSW1	Status word 1 for infeeds	See table: "Status word 1 for infeeds"	FP2457
E_ZSW1_BM	Status word 1 for infeeds, metal industry	See table: "Status word 1 for infeeds, metal industry"	FP2430
NIST_A	Speed setpoint A (16 bit)	r0063[0]	FP4715
NIST_B	Speed setpoint B (32 bit)	r0063	FP4710
IAIST	Actual value of current	r0068[0]	FP6714
MIST	Actual torque value	r0080[0]	FP6714
PIST	Actual power value	r0082[0]	FP6714
NIST_GLATT	Actual speed value smoothed	r0063[1]	FP4715
IAIST_GLATT	Current actual value, smoothed	r0068[1]	FP6714
MIST_GLATT	Torque actual value, smoothed	r0080[1]	FP6714
PIST_GLATT	Power actual value, smoothed	r0082[1]	FP6714
MELD_NAMUR	VIK-NAMUR message bit bar	r3113, see table "NAMUR message bit bar"	--
WARN_CODE	Alarm code	r2132	FP8065
ERROR_CODE	Error code	r2131	FP8060

6.6.6 Creating an S150 in SIMATIC Manager

Once you have called up the hardware manager, you have to choose the Profibus line to which the S150 is to be connected.
In the catalog, double-click the S150 below the "Profibus-DP/Sinamics" folder. A window is displayed in which you can set the S150 bus address. It must be the same as the address on the converter (switch on CU320 or p0918).
To confirm your entries, choose OK. The "Configuration" tab is then displayed in the "DP_Slave_Properties" window.

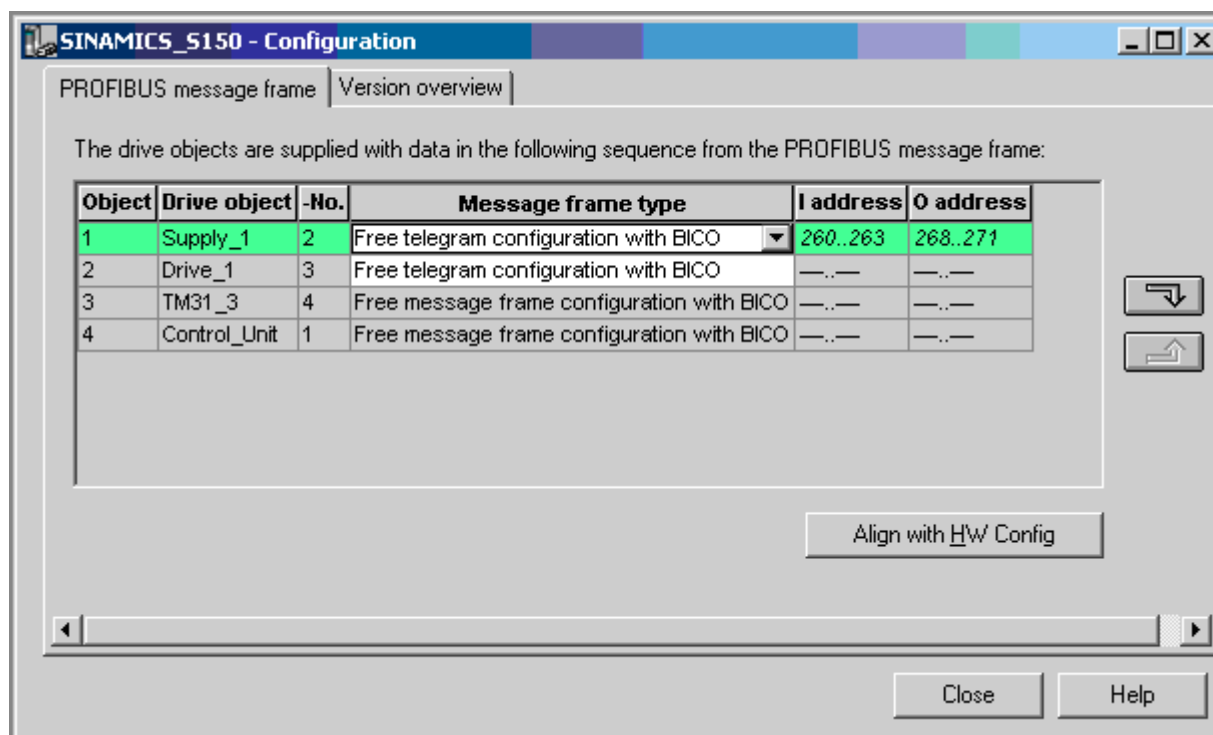


Figure 6-24 SIMATIC screen in HWConfig: DP slave properties S150

The number 1 is entered in the first field under "Object". Standard telegram 1 is defaulted in the field under "Telegram selection".

To display a selection field in which you can select different telegram types, click the standard telegram.

To display or change details (e.g. addresses for peripheral equipment) for the selected telegram, choose the "Details" tab. If you want to use user-definable telegrams (p0922=999) instead of standard telegrams, you can also change the number of PZDs here. The number of PZDs in the send and receive direction does not have to be the same.

Once you have saved your configuration, you have to make a number of settings for the converter. A distinction is made here between using the AOP and the STARTER commissioning tool.

Using the AOP

Once you have carried out basic commissioning for the S150, you have to select the device configuration using CU parameter p0009 = 1. You then have to enter a 3 in CU parameter p0978 index 0 and a 2 in p0978 index 1. Save the data to the EEPROM. To exit the device

configuration, use p0009 = 0. Subsequent activities for interconnecting the process data in the converter are carried out in accordance with the setting for CU parameter p0922 or on the basis of function diagrams FD2410 to FD2483.

Using the STARTER Stand ALONE commissioning tool

Once you have worked through the steps with the device Wizard in STARTER, you have to set parameter p0009 in the Control Unit expert list to 1 (device configuration). You then have to enter a 3 in CU parameter p0978 index 0 and a 2 in p0978 index 1. To exit the device configuration, use p0009 = 0. You must ensure that the new parameters are saved to the EEPROM in online mode.

Using the STARTER and DRIVE ES software tools

If the DRIVE_ES program is installed in addition to the SIMATIC Step 7 program and the STARTER commissioning tool, you can access STARTER directly from SIMATIC Manager. You have to configure the SINAMICS S150 using the device Wizard in STARTER and then open the "Configuration" screen below the drive name.

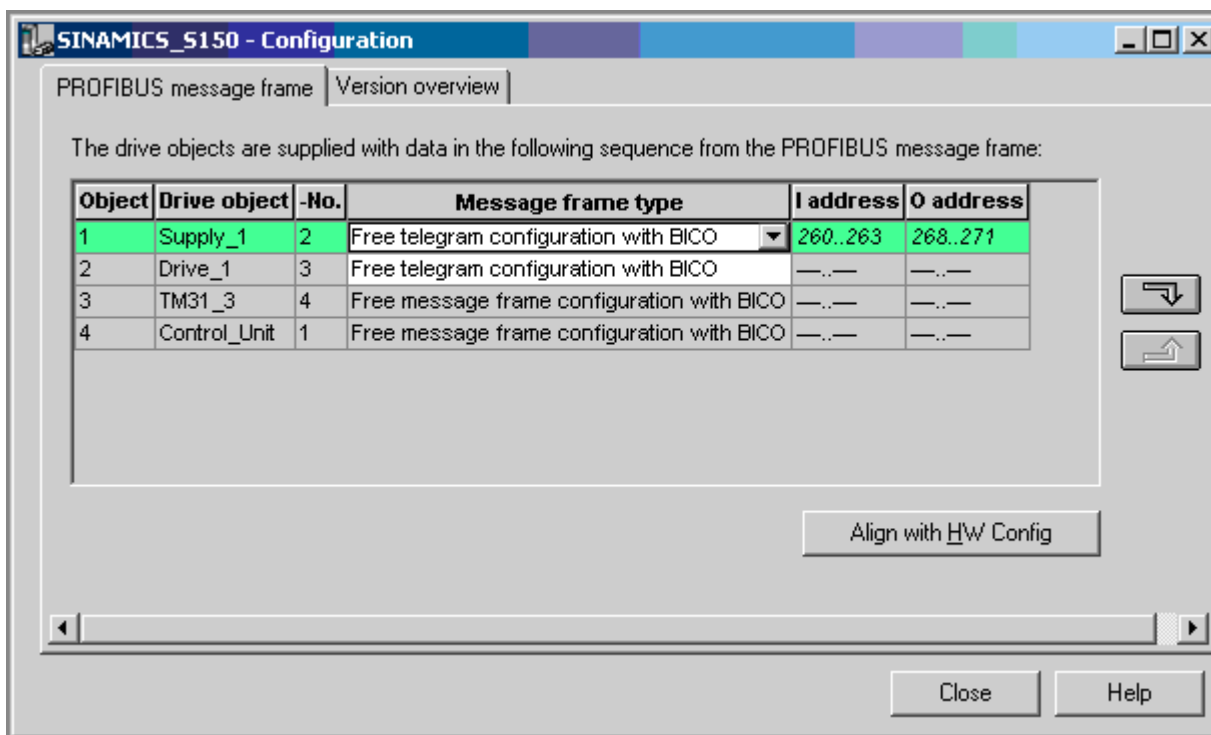


Figure 6-25 STARTER: the "Configuration" screen when opened for the first time

In this screen, the peripheral equipment addresses created in "HWConfig" in SIMATIC Manager are assigned to the infeed rather than the drive. To swap the infeed and drive in the table, click the "down" arrow on the right-hand side of the screen. Now close the screen and open it again. The peripheral equipment addresses are now assigned to the drive. To compare this setting with SIMATIC Manager, click the "Compare with HWConfig" button. The parameters can now be loaded to the converter.

6.7 Control via the operator panel

6.7.1 Operator panel (AOP30) overview and menu structure

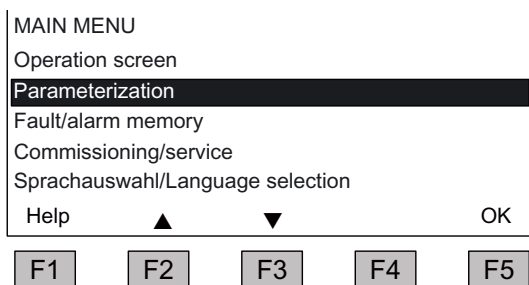
Description

The operator panel can be used for the following activities:

- Parameterization (commissioning)
- Monitoring status variables
- Controlling the drive
- Diagnosing faults and alarms

All the functions can be accessed via a menu.

Your starting point is the main menu, which you can always call up using the yellow MENU key:



Dialog screen for the main menu:
It can be accessed at any time with the "MENU" key.

Press "F2" or "F3" to navigate through the menu options in the main menu.

Menu structure of the operator panel

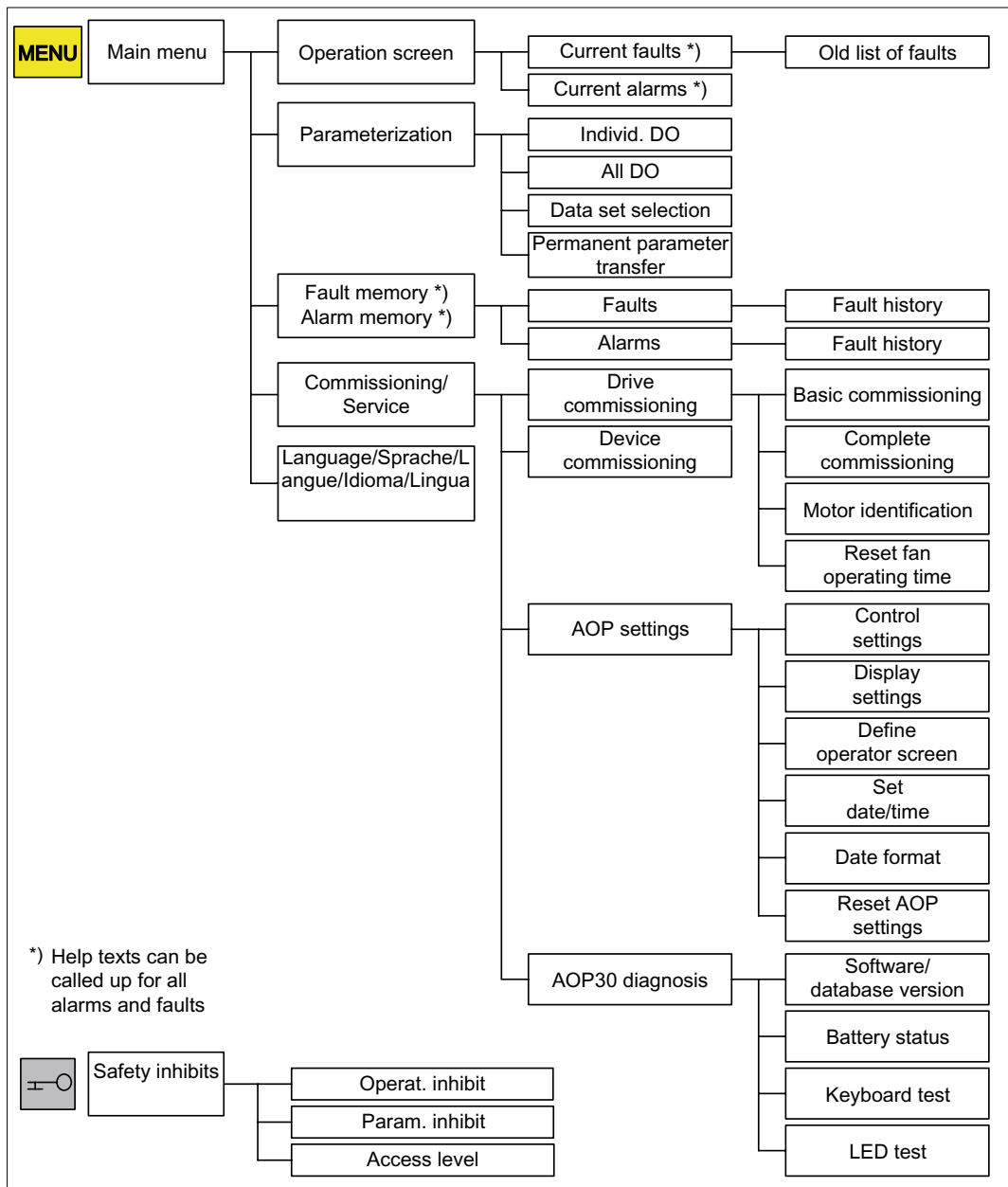


Figure 6-26 Menu structure of the operator panel

6.7.2 Menu: Operation screen

Description

The operation screen displays the most important status variables for the drive unit:

In its as-delivered condition, it displays the operating status of the drive, the direction of rotation, the time, as well as four drive variables (parameters) numerically and two in the form of a bar display for continuous monitoring.

You can call up the operation screen in one of two ways:

1. After the power supply has been switched on and the system has ramped up.
2. By pressing the MENU key twice and then F5 "OK".

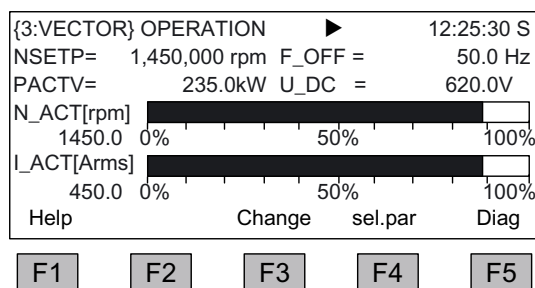


Figure 6-27 Operation screen

If a fault occurs, the system automatically displays the fault screen (see "Faults and alarms").

In LOCAL control mode, you can choose to enter the setpoint numerically (F2: setpoint).

The "Define operation screen" menu can be selected directly using F3 "Change".

The individual parameters of the operation screen can be selected using F4 "Sel. par". The corresponding parameter number of the short identifier is displayed using F1 "Help+" and a description of the parameter can be called up.

Settings

When you choose Commissioning / service → AOP settings → Define operation screen, you can adjust the display type and the values displayed as required (see "Operation / AOP30 settings").

6.7.3 Menu: Parameterization

You can adjust the device settings in the Parameterization menu.

The drive software is modular. The individual modules are called DOs ("drive objects").

The following DOs are available in the SINAMICS S150:

- CU: General parameters for the Control Unit (CU320)
- A_INF Regulated infeed
- VECTOR: Drive control
- TM31: Terminal Module TM31

Parameters with identical functions may exist with the same parameter number in more than one DO (e.g. p0002).

The AOP30 is used for operating devices that comprise more than one drive (in this respect, a regulated infeed is also a "drive") so that attention is focused on one drive (i.e. the "current" drive). You can switch between the drives either in the operation screen or in the main menu. The corresponding function key is labeled "Drive".

This drive determines the following:

- Operation screen
- Fault and alarm displays
- The controller (ON, OFF, ...) of a drive

Depending on your requirements, you can choose between two AOP display types:

1. All parameters
All the parameters present in the device are listed here. The DO to which the parameter currently selected belongs (inverted) is displayed in curly brackets in the top left of the screen.
2. DO selection
In this display, you can pre-select a DO Only the parameters for this DO are then listed. (The expert list display in STARTER only uses this DO view)

In both cases, the set access level governs which parameters are displayed. You can set the access level in the menu for inhibit functions, which can be called up using the key button.

The parameters for access levels 1 and 2 are sufficient for simple applications.

At access level 3 "Expert", you can change the structure of the function by interconnecting BICO parameters.

In the data set selection menu, you can choose which of the data sets chosen is currently DISPLAYED.

Data set parameters are indicated by a "c", "d", "m", "e", or "p" between the parameter number and parameter designator.

When a data set parameter is changed, the data set selection dialog appears.

Data block selection			
Type	Max	Drive	AOP
Command DB	c: <input type="text" value="1"/>	<input type="text" value="0"/>	<input checked="" type="text" value="0"/>
Drive DB	d: <input type="text" value="0"/>	<input type="text" value="0"/>	<input type="text" value="0"/>
Motor DB	m: <input type="text" value="0"/>	<input type="text" value="0"/>	<input type="text" value="0"/>
Help	<input type="text" value="▲"/>	<input type="text" value="▼"/>	Back OK

F1 F2 F3 F4 F5

Figure 6-28 Data set selection

Explanation of the operator control dialog

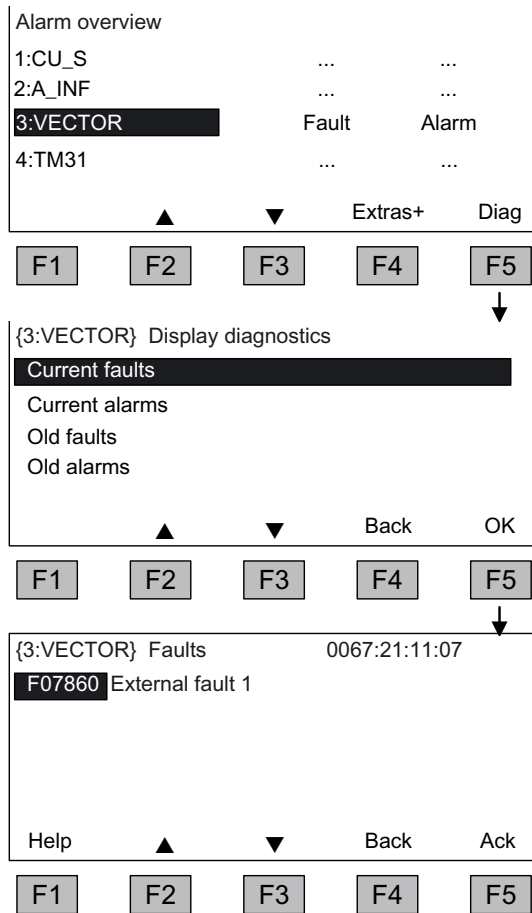
- "Max" shows the maximum number of data sets parameterized (and thereby available for selection) in the drive.
- "Drive" indicates which data set is currently active in the drive.
- "AOP" indicates which particular data set is currently being displayed in the operator panel.

6.7.4 Menu: Fault/alarm memory

When you select the menu, a screen appears containing an overview of faults and alarms that are present.

For each drive object, the system indicates whether any faults or alarms are present. ("Fault" or "Alarm" appears next to the relevant drive object).

In the graphic below, you can see that at least one active fault/alarm is present for the "VECTOR" drive object. No faults/alarms are indicated for the other drive objects.



Fault/alarm memory

When you navigate to the line with active alarms/faults and then press the F5 <Diag> key, the system displays a screen in which you have to select the current or old alarms/faults.

Diagnosis display

When you navigate to the required line and then press the F5 <OK> key, the corresponding faults/alarms are displayed. The list of current faults is selected here as an example.

Current fault display

A maximum of eight current faults are displayed along with their fault number and name of the fault.

To display additional help regarding the cause of the problem and how to solve it, choose F1 <Help>.

To acknowledge the faults, choose F5 <Ack.>. If a fault cannot be acknowledged, the fault remains.

6.7.5 Menu: Commissioning / service

6.7.5.1 Drive commissioning

This option enables you to re-commission the drive from the main menu.

Basic Commissioning

Only the basic commissioning parameters are queried and stored permanently.

Complete commissioning

Complete commissioning with motor and encoder data entry is carried out. Following this, key motor parameters are recalculated from the motor data. The parameter values calculated during previous commissioning are lost.

In a subsequent motor identification procedure, the calculated values are overwritten.

Motor identification

The selection screen for motor identification appears.

Resetting the fan runtime

After a fan replacement, the time counter for monitoring the fan runtime must be reset.

6.7.5.2 Device commissioning

Device commissioning

In this menu, you can enter the device commissioning status directly. This is the only way that you can reset parameters to the factory setting for example.

6.7.5.3 AOP30 settings

Control settings

This defines the settings for the control keys in LOCAL mode (see "Operation / Control via the operator panel / Operation via the operator panel").

Display settings

In this menu, you set the lighting, brightness, and contrast for the display.

Defining the operation screen

In this menu, you can switch between five operation screens. You can set the parameters that are to be displayed.

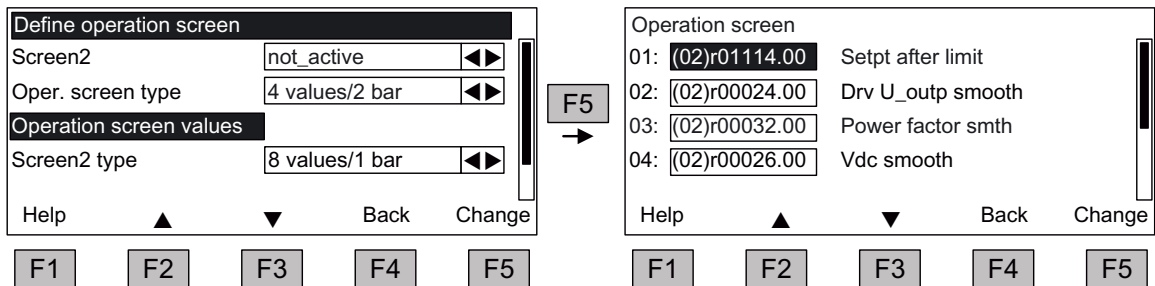


Figure 6-29 Defining the operation screen

The following image shows how the entries are assigned to the screen positions:

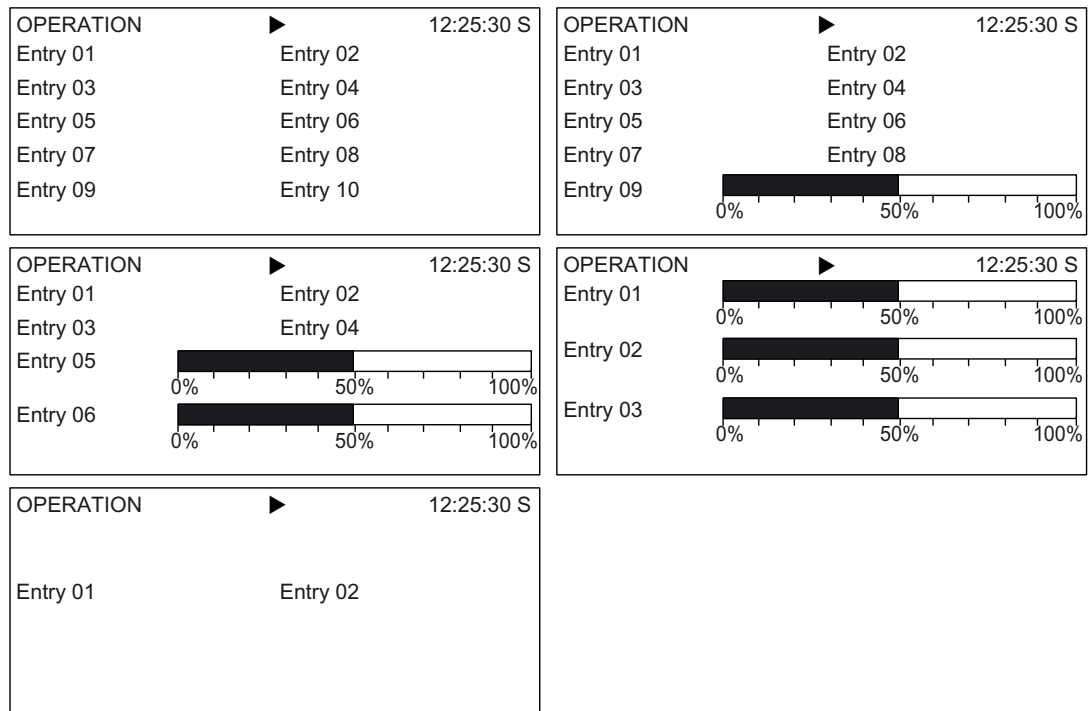


Figure 6-30 Layout of the entries in the operation screen

6.7.5.4 Lists of signals for the operation screen

The following tables list some of the main signals for the operation screen along with the associated reference variables and default settings for fast commissioning.

Vector object

Table 6- 13 List of signals for the operation screen - vector object

Signal	Parameters	Short name	Unit	Scaling (100 %=...) See table below
Factory setting (entry no.)				
Speed setpoint upstream of ramp-function generator	(1) r1114	NSETP	1/min	p2000
Output frequency	(2) r0024	F_OUT	Hz	Reference frequency
Power smoothed	(3) r0032	PACTV	kW	r2004
DC link voltage smoothed	(4) r0026	U_DC	V	p2001
Actual speed smoothed	(5) r0021	N_ACT	1/min	p2000
Absolute actual current smoothed	(6) r0027	I_IST	A	p2002
Motor temperature	(7) r0035 ¹⁾	T_MOT	°C	Reference temperature
Converter temperature	(8) r0037	T_LT	°C	Reference temperature
Actual torque smoothed	(9) r0031	M_ACT	Nm	p2003
Converter output voltage smoothed	(10) r0025	C_OUT	V	p2001
For diagnostic purposes				
Speed setpoint smoothed	r0020	NSETP	1/min	p2000
Control factor smoothed	r0028	AUSST	%	Reference modulation depth
Field-producing current component	r0029	IDACT	A	p2002
Torque-producing current component	r0030	IQACT	A	p2002
Converter overload Degree of thermal overload	r0036	LTI2T	%	100 % = Shutdown
Speed actual value motor encoder	r0061	N_ACT	1/min	p2000
Speed setpoint after filter	r0062	NSETP	1/min	p2000
Actual speed smoothed	r0063	N_ACT	1/min	p2000
Control deviation	r0064	NDIFF	1/min	p2000
Slip frequency	r0065	FSCHL	Hz	Reference frequency
Output frequency	r0066	F_OUT	Hz	Reference frequency
Output voltage	r0072	UACT	V	p2001
Control factor	r0074	AUSST	%	Reference modulation depth
Torque-generating actual current	r0078	IQACT	A	p2002
Actual torque value	r0080	M_ACT	Nm	p2003
For further diagnostic purposes				
Fixed speed setpoint effective	r1024		1/min	p2000
Active motorized potentiometer setpoint	r1050		1/min	p2000
Resulting speed setpoint	r1119	NSETP	1/min	p2000
Speed controller output	r1508	NREGY	Nm	p2003
I component of speed controller	r1482	NREGI	Nm	p2003
PROFIBUS setpoint	r2050	PBSOL	1/min	p2000

¹⁾ If a temperature sensor has not been installed, a value of –200°C is displayed.

Scalings for vector object

Table 6- 14 Scalings for vector object

Size	Scaling parameter	Default for quick commissioning
Reference speed	100 % = p2000	p2000 = Maximum speed (p1082)
Reference voltage	100 % = p2001	p2001 = 1000 V
Reference current	100 % = p2002	p2002 = Current limit (p0640)
Reference torque	100 % = p2003	p2003 = 2 x rated motor torque
Reference power	100 % = r2004	r2004 = (p2003 x p2000 x π) / 30
Reference frequency	100% = p2000/60	
Reference modulation depth	100 % = Maximum output voltage without overload	
Reference flux	100 % = Rated motor flux	
Reference temperature	100% = 100°C	

Object A_INF

Table 6- 15 List of signals for the operation screen - object A_INF

Signal		Parameters	Short name	Unit	Scaling (100 %=-...) See table below
DC link voltage smoothed	(1)	r0026	U_DC	V	p2001
Input voltage	(2)	r0025	U_IN	V	p2001
Active current	(3)	r0030	IACTV	A	p2002
Line frequency	(4)	r0024	FLINE	Hz	p2000
Active power	(5)	r0032	PACTV	kW	r2004
Actual value of current	(6)	r0027	I_IST	A	p2002
Temperature of power unit	(7)	r0037	T_LT	°C	Reference temperature
Power factor, smoothed	(8)	r0032	PACTV	kW	r2004
Modulation depth, smoothed	(9)	r0028	AUSST	%	Reference modulation depth
Reactive current component smoothed	(10)	r0029	IREAC	A	p2002

Scalings for object A_INF

Table 6- 16 Scalings for object A_INF

Variable	Scaling parameter	Default for quick commissioning
Reference frequency	100 % = p2000	p2000 = p0211
Reference voltage	100 % = p2001	p2001 = r0206/r0207
Reference current	100 % = p2002	p2002 = r0207
Reference power	100 % = r2004	r2004 = r0206
Reference modulation depth	100 % = Maximum output voltage without overload	
Reference temperature	100% = 100°C	

TM31 object

Table 6- 17 List of signals for the operation screen – TM31 object

Signal	Parameter	Short name	Unit	Scaling (100 % = ...)
Analog input 0 [V, mA]	r4052[0]	AI_UI	V, mA	V: 100 V / mA: 100 mA
Analog input 1 [V, mA]	r4052[1]	AI_UI	V, mA	V: 100 V / mA: 100 mA
Analog input 0, scaled	r4055[0]	AI_%	%	as set in p200x
Analog input 1, scaled	r4055[1]	AI_%	%	as set in p200x

Setting the date/time (for date stamping of error messages)

In this menu, you set the date and time.

You can also set whether and/or how the AOP and drive unit are to be synchronized. Synchronization of the AOP with the drive enables error messages to be date- and time-stamped.

- None (factory setting)
The times for the AOP and drive unit are not synchronized.
- AOP -> Drive
 - If you activate this option, the AOP and drive unit are synchronized immediately whereby the current AOP time is transferred to the drive unit.
 - The current AOP time is transferred to the drive unit every time the AOP is started.
 - At 02:00 (AOP time) every day, the current AOP time is transferred to the drive unit.
- Drive -> AOP
 - If you activate this option, the AOP and drive unit are synchronized immediately whereby the current drive unit time is transferred to the AOP.
 - The current drive unit time is transferred to the AOP every time the AOP is started.
 - At 02:00 (AOP time) every day, the current drive unit time is transferred to the AOP.

Date format

In this menu, the date format can be set:

- DD.MM.YYYY: European date format
- MM/DD/YYYY: North American data format

Resetting AOP settings

When you choose this menu option, the AOP factory settings for the following are restored:

- Language
- Display (brightness, contrast)
- Operation screen
- Control settings

NOTICE
When you reset parameters, all settings that are different to the factory settings are reset immediately. This may cause the cabinet unit to switch to a different, unwanted operational status. For this reason, you should always take great care when resetting parameters.

6.7.5.5 AOP30 diagnosis

Software/database version

You can use this menu to display the firmware and database versions.

The database version must be compatible with the drive software status (you can check this in parameter r0018).

Battery status

In this menu, you can display the battery voltage numerically (in Volts) or as a bar display. The battery ensures that the data in the database and the current time are retained.

When the battery voltage is represented as a percentage, a battery voltage of ≤ 2 V is equal to 0%, and a voltage of ≥ 3 V to 100%.

The data is secure up to a battery voltage of 2 V.

- If the battery voltage is ≤ 2.45 V, the message "Replace battery" is displayed in the status bar.
- If the battery voltage is ≤ 2.30 V, the system displays the following message: "Warning: weak battery".
- If the battery voltage is ≤ 2 V, the system displays the following message: "Warning: battery is empty".
- If the time and/or database are not available after the system has been switched off for a prolonged period due to the voltage being too low, the loss is established by means of a CRC check when the system is switched on again. This triggers a message instructing the user to replace the battery and then load the database and/or set the time.

For instructions on how to change the battery, see "Maintenance and servicing".

Keyboard test

In this screen, you can check that the keys are functioning properly. Keys that you press are represented on a symbolic keyboard on the display. You can press the keys in any order you wish. You cannot exit the screen (F4 – "back") until you have pressed each key at least once.

Note

You can also exit the key test screen by pressing any key and keeping it pressed.

LED test

In this screen, you can check that the 4 LEDs are functioning properly.

6.7.6 Language/Sprache/Langue/Idioma/Lingua

The operator panel downloads the texts for the different languages from the drive.

You can change the language of the operator panel via the "Language/Sprache/Langue/Idioma/Lingua" menu.

Note**Additional languages for the display**

Languages in addition to the current available languages in the display are available on request.

6.7.7 Operation via the operator panel (LOCAL mode)

You activate the control keys by switching to LOCAL mode. If the green LED in the LOCAL/REMOTE key does not light up, the key is not active.

Note

If the "OFF in REMOTE" function is activated, the LED in the LOCAL-REMOTE key flashes.

For LOCAL master control, all of the supplementary setpoints are de-activated.

After the master control has been transferred to the operator panel, the BICO interconnections at bit 0 to bit 10 of the control word of the sequence control are not effective (refer to function diagram 2501).

6.7.7.1 LOCAL/REMOTE key



Activate LOCAL mode: Press the LOCAL key.

LOCAL mode: LED lights up

REMOTE mode: LED does not light up: the ON, OFF, JOG, direction reversal, faster, and slower keys are not active.

Settings: Menu – Commissioning / Service – AOP Settings – Control Settings

Save LOCAL mode (factory setting: yes)

- **Yes:** The "LOCAL" or "REMOTE" operating mode is saved when the power supply is switched off and restored when the power supply is switched back on.
- **No:** "LOCAL" or "REMOTE" operating mode is not saved. "REMOTE" is active when the supply voltage is switched back on.

OFF in REMOTE (factory setting: no)

- **Yes:** The OFF key functions in REMOTE mode even if the drive is being controlled by external sources (PROFIBUS, customer terminal strip, NAMUR terminal strip).
WARNING This function is not an EMERGENCY STOP function!
- **No:** The OFF key is only effective in LOCAL mode.

LOCAL/REMOTE also during operation (factory setting: no)

- **Yes:** You can switch between LOCAL and REMOTE when the drive is switched on (motor is running).
- **No:** Before the system switches to LOCAL, a check is carried out to determine whether the drive is in the operational status. If so, the system does not switch to LOCAL and outputs the message "Local not possible". Before the system switches to REMOTE, the drive is switched off and the setpoint is set to 0.

6.7.7.2 ON key / OFF key



ON key: always active in LOCAL when the operator input inhibit is deactivated.

OFF key: in the factory setting, acts as OFF1 = ramp-down at the deceleration ramp (p1121); when n = 0: voltage disconnection (only if a main contactor is installed)
The OFF key is effective in the LOCAL mode and when the "OFF in REMOTE" function is active.

Settings: Menu – Commissioning / Service – AOP Settings – Control Settings

Red OFF key acts as: (factory setting: OFF1)

- **OFF1:** Ramp-down on the deceleration ramp (p1121)
- **OFF2:** Immediate pulse block, motor coasts to a standstill
- **OFF3:** Ramp-down on the emergency stop ramp (p1135)

6.7.7.3 Switching between clockwise and counter-clockwise rotation



Settings: Menu – Commissioning / Service – AOP Settings – Control Settings

Switching between CCW/CW (factory setting: no)

- **Yes:** Switching between CW/CCW rotation by means of the CW/CCW key possible in LOCAL mode
- **No:** The CW/CCW key has no effect in LOCAL mode

For safety reasons, the CW/CCW key is disabled in the factory setting (pumps and fans must normally only be operated in one direction).

In the operation status in LOCAL mode, the current direction of rotation is indicated by an arrow next to the operating mode.

Note

You have to make additional settings when switching between CW/CCW rotation.

6.7.7.4 Jog



Settings: Menu – Commissioning / Service – AOP Settings – Control Settings

JOG key active (factory setting: no)

- **Yes:** The jog key is effective in the LOCAL mode in the state "ready to power-up" (not in "operation"). The speed that is set in parameter p1058 is approached.
- **No:** The JOG key has no effect in LOCAL mode

6.7.7.5 Increase setpoint / decrease setpoint



You can use the increase and decrease keys to set the setpoint with a resolution of 1min^{-1} of the maximum speed.

You can also enter the setpoint numerically. To do so, press F2 in the operation screen. The system displays an inverted edit field for entering the required speed. Enter the required value using the numeric keypad. Press F5 "OK" to confirm the setpoint.

When you enter values numerically, you can enter any speed between the minimum speed (p1080) and the maximum speed (p1082).

Setpoint entry in LOCAL mode is unipolar. You can change the direction of rotation by pressing the key that allows you to switch between CW/CCW rotation.

- CW rotation and "Increase key" mean:
The displayed setpoint is positive and the output frequency is increased.
- CCW rotation and "Increase key" mean:
The displayed setpoint is negative and the output frequency is increased.

6.7.7.6 AOP setpoint

Settings: MENU – Commissioning/Service – AOP Settings – Control Settings

Save AOP setpoint (factory setting: no)

- **Yes:** In LOCAL mode, the last setpoint (once you have released the INCREASE or DECREASE key or confirmed a numeric entry) is saved. The next time you switch the system on in LOCAL mode, the saved value is selected. This is also the case if you switched to REMOTE in the meantime or the power supply was switched off. When the system is switched from REMOTE to LOCAL mode while the drive is switched on (motor is running), the actual value that was last present is set as the output value for the motorized potentiometer setpoint and saved. If the system is switched from REMOTE to LOCAL mode while the drive is switched off, the motorized potentiometer setpoint that was last saved is used.
- **No:** On power-up in LOCAL mode, the speed is always set to the value entered under "AOP starting setpoint". When the system is switched from REMOTE to LOCAL mode while the drive is switched on (motor is running), the actual value that was last present is set as the output value for the AOP setpoint.

AOP setpoint ramp-up time (factory setting: 10 s)

AOP setpoint ramp-down time (factory setting: 10 s)

- **Recommendation:** set as ramp-up/ramp-down time (p1120 / p1121). Changing the ramp-up/ramp-down times does not affect the settings for parameters p1120 and p1121 because this is an AOP-specific setting.

AOP starting setpoint (factory setting: 0.000 rpm)

Note

The internal drive ramp-function generator is always active.

Settings: MENU – Commissioning/Service – AOP Settings – Control Settings

Save AOP local mode (factory setting: no)

- **Yes:** Deactivates the "Control via operator panel" function, thereby disabling the LOCAL/REMOTE key.
- **No:** Activates the LOCAL/REMOTE key.

Note

LOCAL functionality can also be locked on the drive by means of the p0806 parameter (BI: Lock master control).

Settings: MENU – Commissioning/Service – AOP Settings – Control Settings

Acknowledge error from the AOP (factory setting: yes)

- **Yes:** Errors can be acknowledged via the AOP.
- **No:** Errors cannot be acknowledged via the AOP.

6.7.7.7 Timeout monitoring

In "LOCAL" mode or if "OFF in REMOTE" is active, the drive is shut down after 1 s if the data cable between the AOP and drive is disconnected.

6.7.7.8 Operator input inhibit / parameterization inhibit



To prevent users from accidentally actuating the control keys and changing parameters, you can activate an operator input / parameters disable using a key pushbutton. Two key icons appear in the top right of the display when these inhibit functions are enabled.

Table 6- 18 Display of operator input/parameters disable

Inhibit type	Online operation	Offline operation
No inhibit		
Operator input inhibit		
Parameters disable		
Operator input inhibit + parameters disable		

Settings

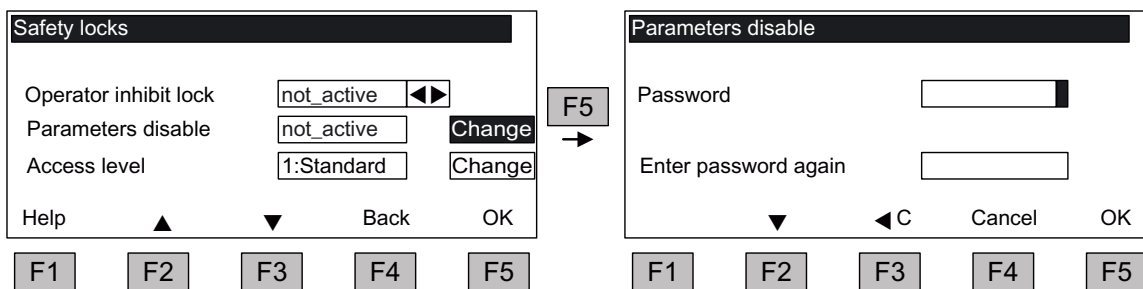


Figure 6-31 Set inhibit functions

The "Operator input inhibit" setting can be changed directly via <F5> "Change" once you have selected the selection field.

When "Parameterization inhibit" is activated, you have to enter a numeric password (repeat this entry). You must also enter this password when deactivating "Parameterization inhibit".

Operator input inhibit (factory setting: not active)

- **Active:** The parameters can still be viewed, but a parameter value cannot be saved (message: "Note: operator input inhibit active"). The OFF key (red) is enabled. The LOCAL, REMOTE, ON (green), JOG, CW/CCW, INCREASE, and DECREASE keys are disabled.

Parameterization inhibit (factory setting: not active)

- **Active:** Parameters cannot be changed unless a password is entered. The parameterization process is the same as with the operator input inhibit. If you try and change parameters, the message "Note: Parameterization inhibit active" is displayed. All the control keys can, however, still be actuated.

Access level (factory setting: Expert):

The different parameters required for this complex application are filtered so that they can be displayed as clearly as possible. You select them according to the access level.

An expert level, which must only be used by expert personnel, is required for certain actions.

6.7.8 Faults and alarms

Indicating faults and alarms

If a fault occurs, the drive displays the fault and/or alarm on the operator panel. Faults are indicated by the red "FAULT" LED and a fault screen is automatically displayed. You can use the F1 Help function to call up information about the cause of the fault and how to remedy it. You can use F5 Ack. to acknowledge a stored fault.

Alarms are indicated by means of the yellow "ALARM" LED. The system also displays a note in the status bar providing information on the cause.

What is a fault?

A fault is a message from the drive indicating an error or other exceptional (unwanted) status that causes the drive to shutdown. This could be caused by a fault within the converter or an external fault triggered, for example, by the winding temperature monitor for the motor. The faults are displayed and can be reported to a higher-level control system via PROFIBUS. In the factory default setting, the message "converter fault" is also sent to a relay output. Once you have rectified the cause of the fault, you have to acknowledge the fault message.

What is an alarm?

An alarm is the response to a fault condition identified by the drive. It does not result in the drive being switched off and does not have to be acknowledged. Alarms are "self acknowledging", that is, they are reset automatically when the cause of the alarm has been eliminated.

Fault and alarm displays

Every fault and alarm is entered in the fault/alarm buffer along with time the error occurred. The time stamp refers to the relative system time in milliseconds (r0969).

You can call up an overview screen that displays the current status of faults and/or alarms for every drive object in the system by choosing MENU – Fault memory / alarm memory.

A context menu featuring the "Back" and "Quit" options appears when you press F4 "Next". The function required can be selected using F2 and F3 and executed by pressing F5 "OK". The "Acknowledge" function sends an acknowledgement signal to each drive object. The red FAULT LED extinguishes once all the faults have been acknowledged.

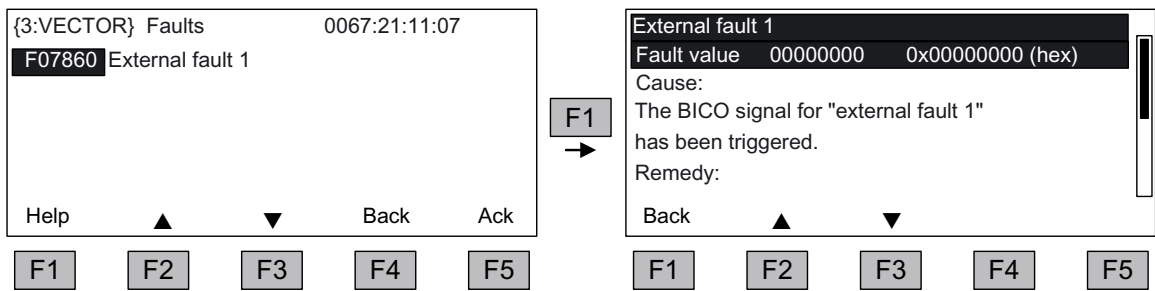


Figure 6-32 Fault screen

You can use F5 Ack. to acknowledge a stored fault.

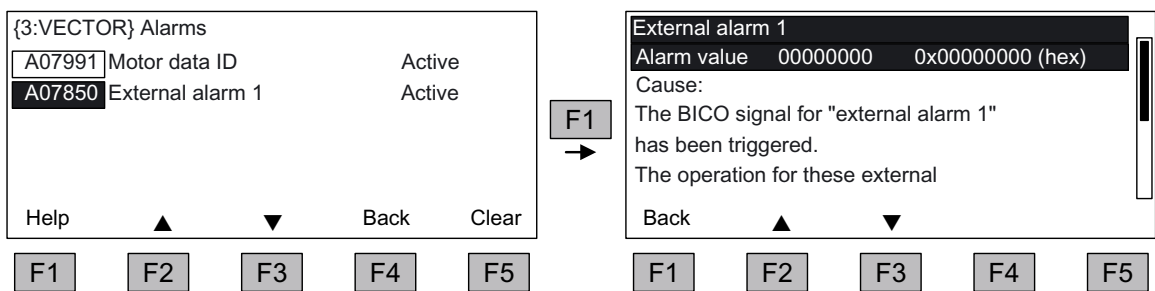


Figure 6-33 Alarm screen

Alarms that are no longer active are removed from the alarm memory with F5 Clear.

6.7.9 Saving the parameters permanently

Description

If parameters have been changed using the operator panel (confirm with OK in the Parameter Editor), the new values are initially stored in the volatile memory (RAM) of the converter. An "S" flashes in the top right of the AOP display until they are saved to a permanent memory. This indicates that at least 1 parameter has been changed and not yet stored permanently.

Two methods are available for permanently saving parameters that have been changed:

- To store the parameters permanently, choose <MENU> <Parameterization> <OK> <Permanent parameter transfer>.
- When confirming a parameter setting with OK, press the OK key for > 1 s. The system displays a message asking you whether the setting is to be saved in the EEPROM. If you press "Yes", the system saves the setting in the EEPROM. If you press "No", the setting is not saved permanently and the "S" starts flashing.

In both cases, **all** changes that have not yet been saved permanently are stored in the EEPROM.

6.7.10 Parameterization errors

If a fault occurs when reading or writing parameters, a popup window containing the cause of the problem is displayed.

The system displays:

Parameter write error (d)pxxx.yy:0xnn

and a plain-text explanation of the type of parameterization error.

6.8 PROFINET IO

6.8.1 Activating online operation: STARTER via PROFINET IO

Description

The following options are available for online operation via PROFINET IO:

- Online operation via IP

Prerequisites

- STARTER with version $\geq 4.1.1$
- Firmware version $\geq 2.5.1$
- CBE20

STARTER via PROFINET IO (example)

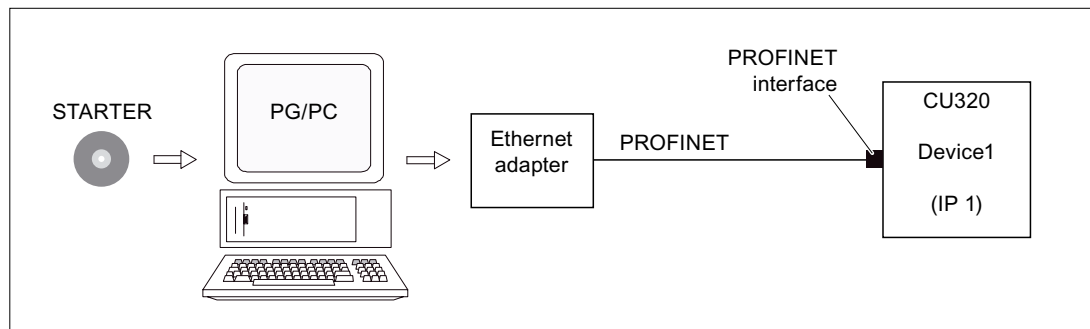


Figure 6-34 STARTER via PROFINET (example)

Procedure, establishing online operation with PROFINET

1. Set the IP address in Windows XP
The PC/PG is referred here to a fixed, free IP address.
2. Settings in STARTER
3. Assignment of the IP address and the name for the PROFINET interface of the drive unit
The PROFINET interface must be "baptized" so that the STARTER can establish communication.
4. Select online operation in STARTER.

Set the IP address in Windows XP

On the desktop, right-click on "Network environment" -> Properties -> double-click on Network card and choose -> Properties -> Internet Protocol (TCP/IP) -> Properties -> Enter the freely-assignable addresses.

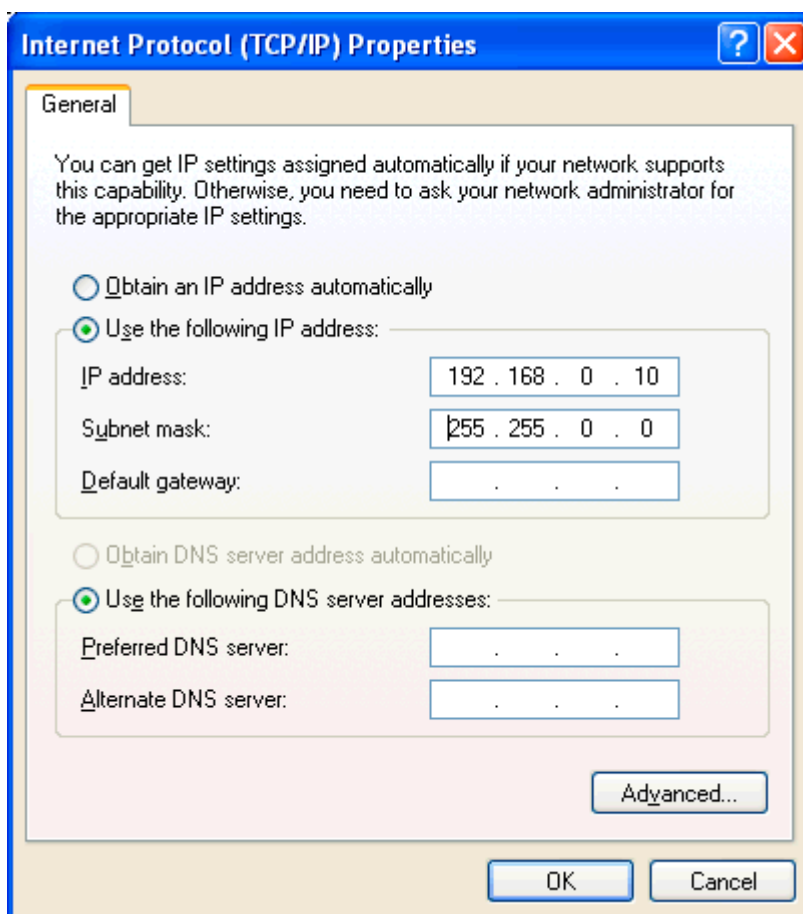


Figure 6-35 Properties of the Internet Protocol (TCP/IP)

Settings in STARTER

The following settings are required in STARTER for communication via PROFINET:

- Extras -> Set PG/PC interface

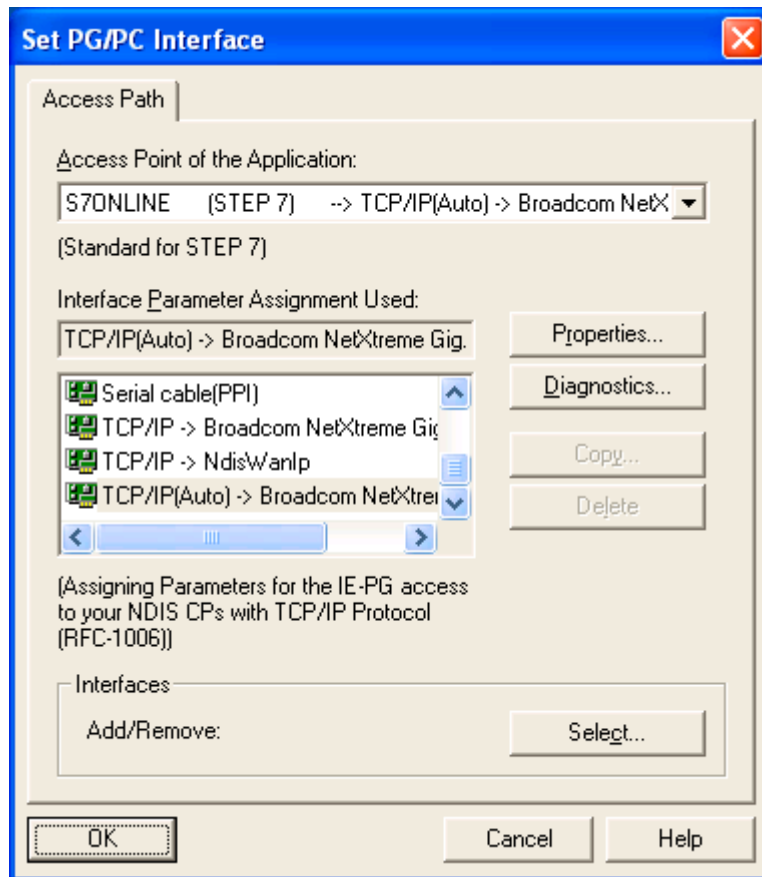


Figure 6-36 Set the PG/PC interface

Assignment of the IP address and the name for the PROFINET interface of the drive unit

Use the STARTER to assign an IP address and a name to the PROFINET interface (e.g. CBE20).

Requirement:

- Connect the direct Ethernet cable from the PG/PC to the PROFINET interface of the CU320 Control Unit.
- Switch on Control Unit CU320

The accessible nodes must be searched in the STARTER:

- Project -> Accessible nodes

Subsequently the nodes found are displayed in the interactive screen.

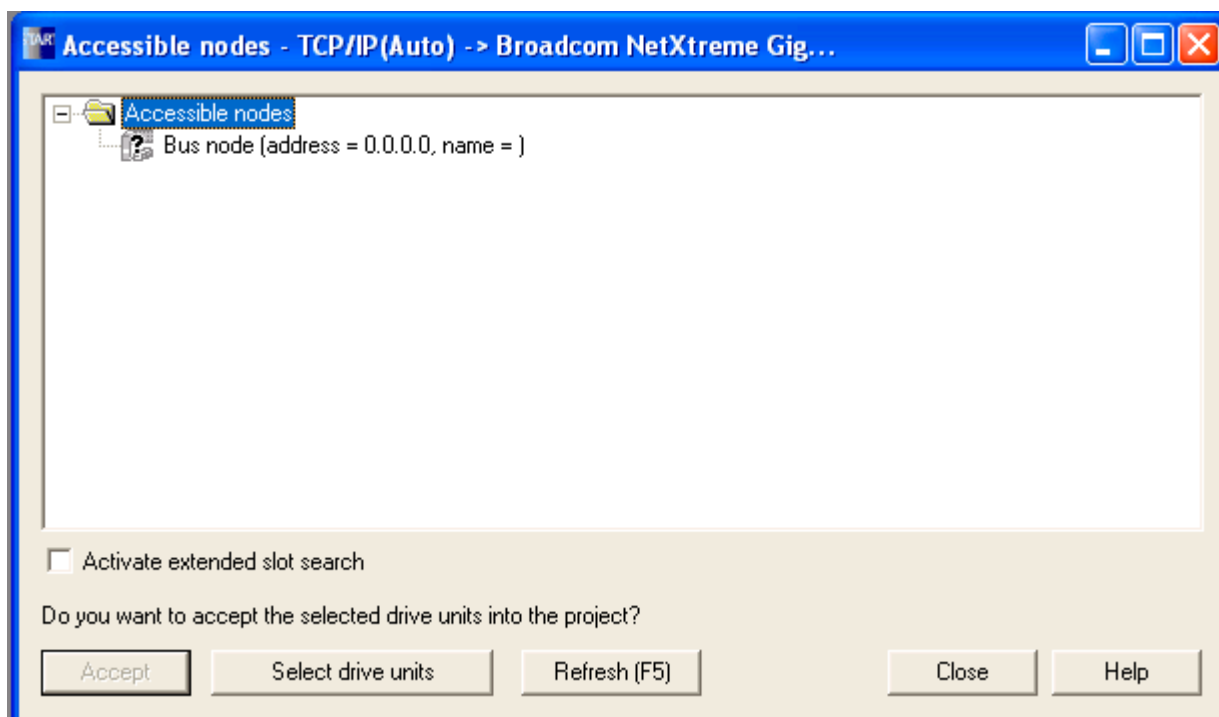


Figure 6-37 STARTER -> Accessible nodes

The selected node is edited by selecting the field for the node with the right mouse button and selecting the option "Edit Ethernet node...".

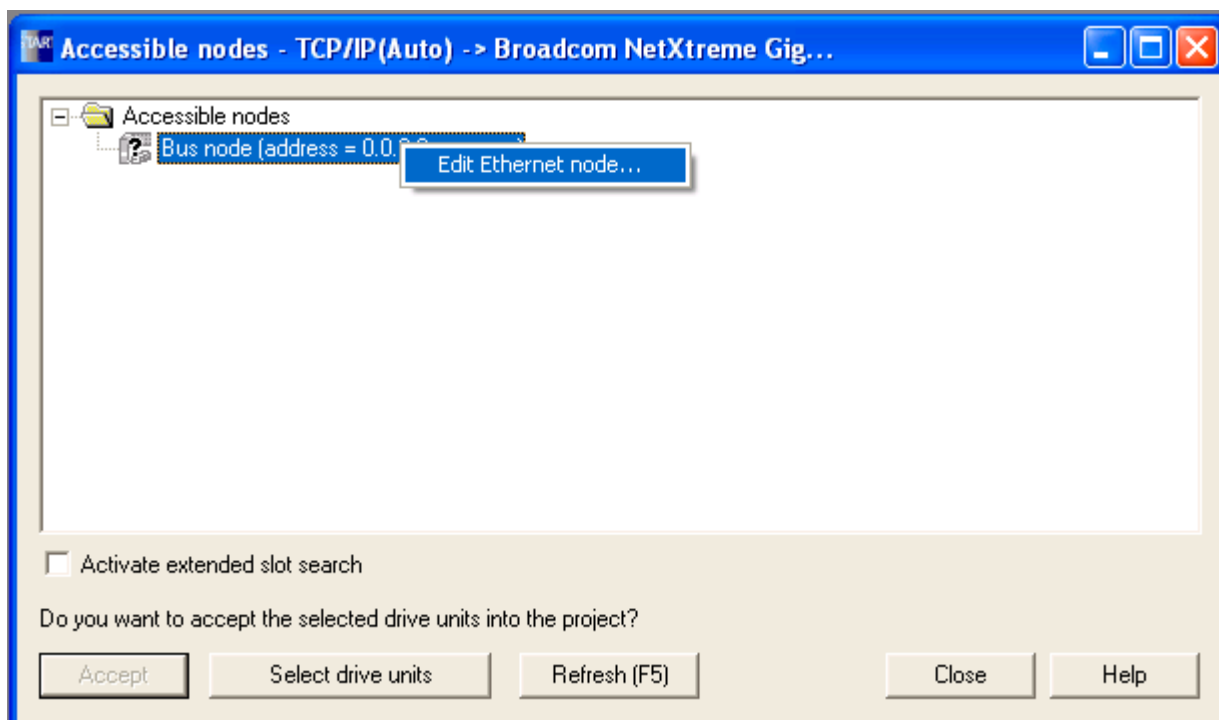


Figure 6-38 STARTER - Accessible nodes - Edit Ethernet node

In the following interactive screen enter a freely selectable device name and the IP address and subnet mask.

The subnet screens must match before STARTER can be run.

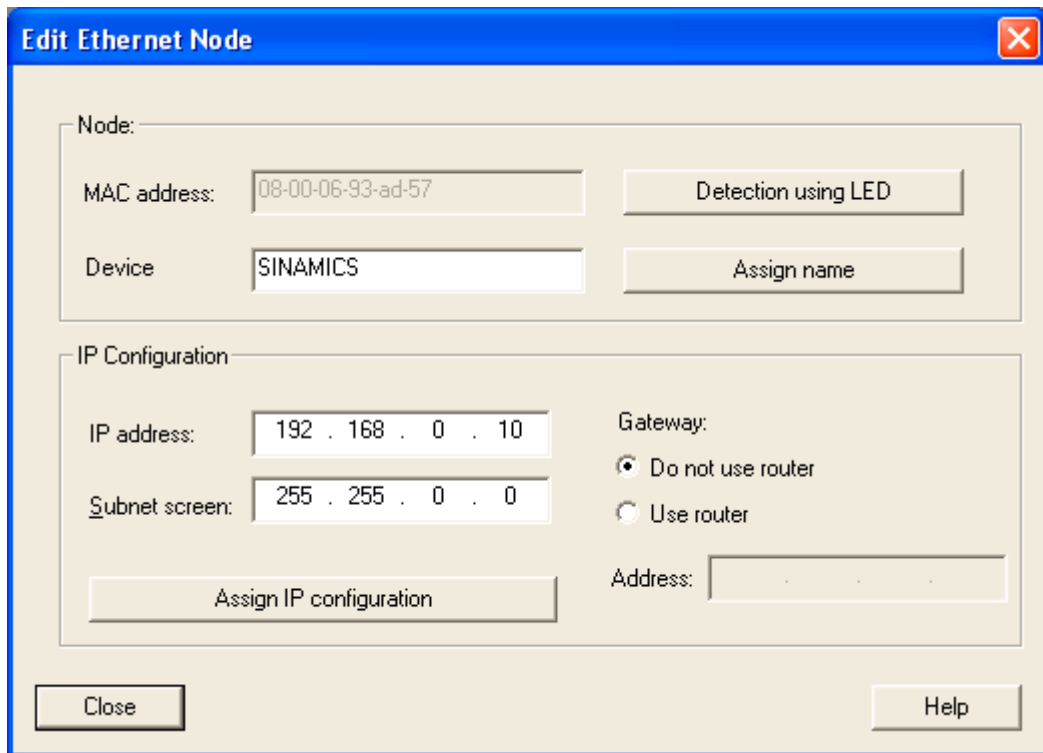


Figure 6-39 STARTER - Edit Ethernet nodes

After selecting the "Assign name" button, the following confirmation will appear if the assignment was successful.

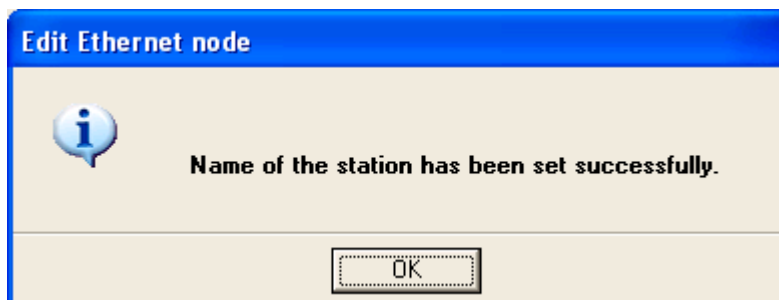


Figure 6-40 STARTER - Successful assignment of the device name

After selecting the "Assign IP configuration" button, the following confirmation will appear if the assignment was successful.

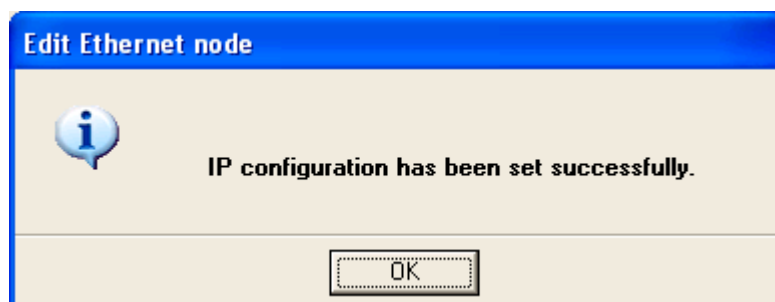


Figure 6-41 STARTER - Successful assignment of the IP configuration

After closing the "Edit Ethernet node" interactive screen the successful "christening" of the node is displayed in the node overview after updating (F5).

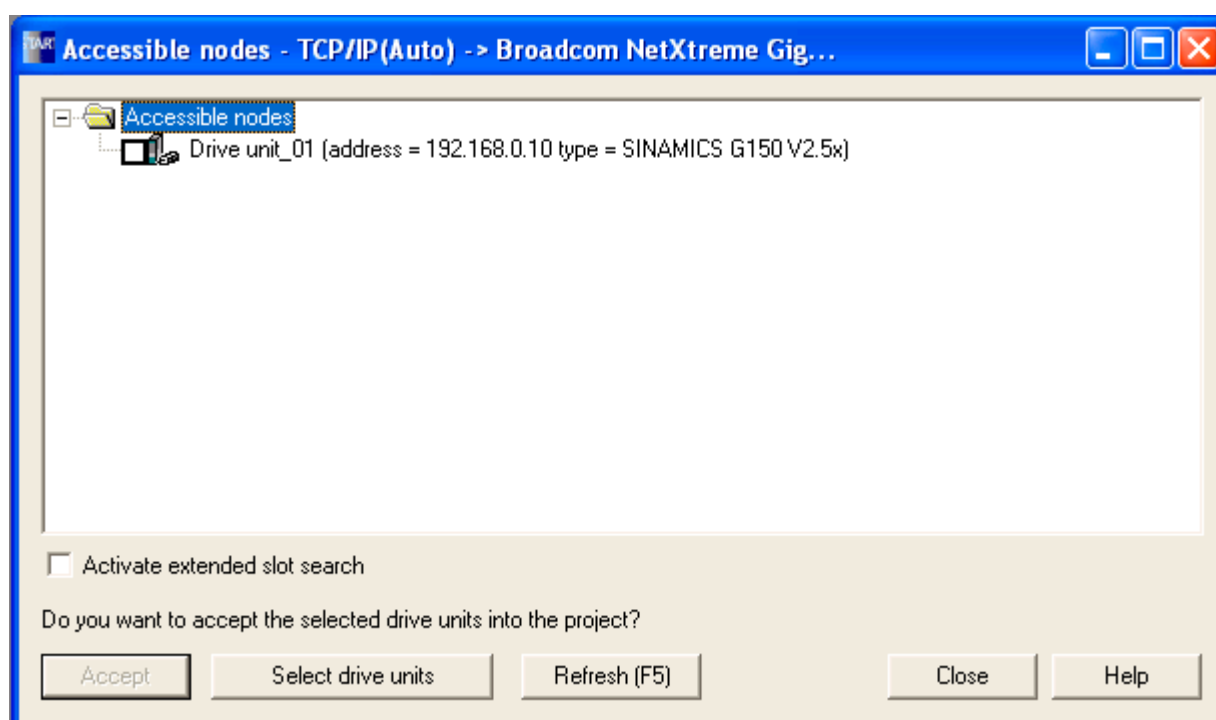


Figure 6-42 STARTER - Accessible nodes update completed

Note

The IP address and device name for the Control Unit are stored on the CompactFlash Card (non-volatile).

6.8.2 General information about PROFINET IO

6.8.2.1 General information about PROFINET IO for SINAMICS

General information

PROFINET IO is an open Industrial Ethernet standard for a wide range of production and process automation applications. PROFINET IO is based on Industrial Ethernet and observes TCP/IP and IT standards.

The following standards ensure open, multi-vendor systems:

- International standard IEC 61158

PROFINET IO is optimized for high-speed, time-critical data communication at field level.

PROFINET

Within the framework of Totally Integrated Automation (TIA), PROFINET represents a consequent enhancement of:

- PROFIBUS DP, the established field bus, and
- Industrial Ethernet, the communications bus for the cell level.

Experience gained from both systems was and is being integrated into PROFINET. As an Ethernet-based automation standard defined by PROFIBUS International (PROFIBUS user organization), PROFINET is a manufacturer-independent communication and engineering model.

When a CBE20 Communication Board is inserted, SINAMICS S150 becomes an IO device in terms of PROFINET. SINAMICS S150 and CBE20 can be used for communication via PROFINET IO with RT.

CAUTION
Inserting the CBE20 Communication Board deactivates the cyclic PZD channel for PROFIBUS DP.

Note

PROFINET for drive technology is standardized and described in the following document:

References:

PROFIdrive Profile Drive Technology

PROFINET System Description,

Order no. 6ES7398-8FA10-8AA0, 6ES7151-1AA10-8AA0

6.8.2.2 Real-time (RT) and isochronous real-time (IRT) communication

Real-time communication

If supervisors are involved in communication, this can result in excessively long runtimes for the production automation system. When communicating time-critical IO user data, PROFINET therefore uses its own real time channel, rather than TCP/IP.

Definition: Real Time (RT) and determinism

Real time means that a system processes external events over a defined period.

Determinism means that a system responds in a predictable manner (deterministically).

In industrial networks, both of these requirements are important. PROFINET meets these requirements. PROFINET is implemented as a deterministic real time network as follows:

- Transmission of time-critical data takes place at guaranteed time intervals. To achieve this, PROFINET provides an optimized communication channel for real time communication: Real Time (RT).
- An exact prediction of the time at which the data transfer takes place is possible.
- Problem-free communication using other standard protocols is guaranteed within the same network.

Definition: Isochronous real time communication (IRT)

Isochronous Real Time Ethernet: Real time properties of PROFINET IO where IRT telegrams are transmitted deterministically via planned communication paths in a defined sequence to achieve the best possible synchronism and performance. This is also known as time-scheduled communications whereby knowledge about the network structure is utilized. IRT requires special network components that support planned data transfer.

When the transfer procedure is implemented in the ERTEC ASICs (Enhanced Real-Time Ethernet Controller), this results in cycle times of at least 500 μ s and a jitter accuracy of less than 1 μ s.

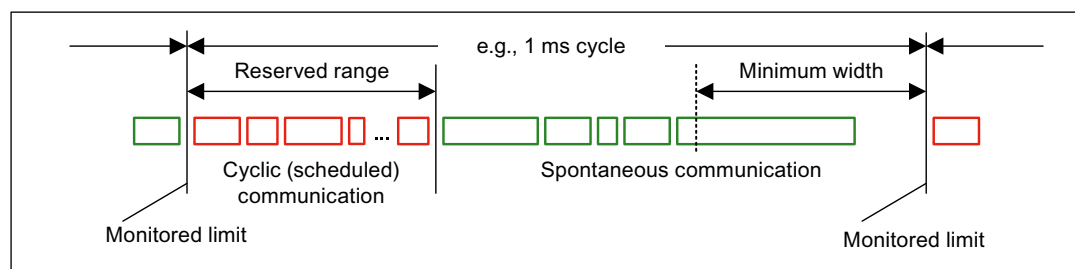


Figure 6-43 Broadband distribution/reservation, PROFINET IO IRT

Note

When operating S7-300 stations with SINAMICS drives, presently only communications via PROFINET IO with RT are possible.

6.8.2.3 Addresses

Definition: MAC address

Each PROFINET device is assigned a worldwide unique device identifier in the factory. This 6-byte long device identifier is the MAC address. The MAC address is divided up as follows:

- 3 bytes manufacturer's ID and
- 3 bytes device identifier (consecutive number).

The MAC address is usually indicated on the front of the device.

e.g.: 08-00-06-6B-80-C0

IP address

To allow a PROFINET device to be addressed as a node on Industrial Ethernet, this device also requires an IP address that is unique within the network. The IP address is made up of 4 decimal numbers with a range of values from 0 through 255. The decimal numbers are separated by a period. The IP address is made up of

- The address of the (sub-) network and
- The address of the node (generally called the host or network node)

IP address assignment

The TCP/IP protocol is a prerequisite for establishing a connection and parameterization. This is the reason that an IP address is required.

The IP addresses of IO devices can be assigned by the IO controller and always have the same sub-network mask as the IO controller. They can be consecutively assigned from the IP address of the IO controller. The IP address can be changed manually, if necessary - and is saved in a volatile fashion.

If the IP address is to be stored in a non-volatile memory, the address must be assigned using the Primary Setup Tool (PST) or STARTER.

This can also be carried out in HWConfig in STEP 7, where the function is called "Edit Ethernet node".

Note

If the network is part of an existing Ethernet company network, obtain the information from your network administrator (IP address, sub-network mask and a router that is possibly being used.)

Device name

When it is shipped, an IO device does not have a device name. An IO device can only be addressed by an IO controller, for example, for the transfer of project engineering data (including the IP address) during startup or for user data exchange in cyclic operation, after it has been assigned a device name with the IO supervisor.

NOTICE

The device name must be saved in a non-volatile fashion either using the Primary Setup Tool (PST) or using HW Config from STEP 7.

Replacing Control Unit CU320 (IO device)

If the IP address and device name are stored in a non-volatile memory, this data is also forwarded with the memory card (CF card) of the Control Unit.

If an IO device must be completely replaced due to a device or module defect, the Control Unit automatically assigns parameters and configures the new device or module. Following this, cyclic exchange of user data is restarted. The CF card allows module exchange without an IO supervisor when a fault occurs in a PROFINET device.

Definition: Sub-network mask

The bits set in the sub-network define the part of the IP address that contains the address of the (sub-)network. The following generally applies:

- The network address is obtained by an AND operation on the IP address and sub-network mask
- The node address is obtained by an AND NOT operation on the IP address and sub-network mask.

Example of the sub-network mask

Sub-network mask: 255.255.0.0 (decimal) = 11111111.11111111.00000000.00000000 (binary)
IP address: 140.80.0.2, significance: The first 2 bytes of the IP address decide the sub-network - in other words 140.80. The last two bytes address the node - in other words 0.2.

Default router

If data needs to be forwarded by means of TCP/IP to a partner located outside the sub-network, this is carried out via the default router. In the properties dialog in STEP 7 (Properties of Ethernet interface > Parameters > Network transfer), the default router is described as the router. STEP 7 assigns the local IP address to the default router.

6.8.2.4 Data transmission

Features

The Communication Board CBE20 supports:

- IRT – isochronous real-time Ethernet
- RT – real-time Ethernet
- Standard Ethernet services (TCP/IP, LLDP, UDP and DCP)

PROFIdrive telegram for cyclic data transmission and non-cyclic services

Telegrams to send and receive process data are available for each drive object of a drive unit with cyclic process data exchange. In addition to cyclic data transfer, acyclic services can also be used for parameterizing and configuring the drive. These acyclic services can be used by the supervisor or the controller.

The total length of the Ethernet frame increases with the number of drive objects in a drive unit.

Sequence of drive objects in the data transfer

The sequence of drive objects is displayed via a list in p0978[0...15] where it can also be changed.

Note

The sequence of drive objects in HW Config must be the same as that in the drive (p0978).

NOTICE

A ring-type topology is not permissible.
--

6.8.3 Further information about communication via PROFINET IO

Further information about communication via PROFINET IO

For more information about the PROFINET IO communication, refer to the section "PROFIBUS DP/PROFINET IO communication" in the documentation "SINAMICS S120 Function Manual".

6.9 Engineering Software Drive Control Chart (DCC)

Graphical configuring and expansion of the device functionality by means of freely available closed-loop control, arithmetic, and logic function blocks

Drive Control Chart (DCC) expands the facility for the simplest possible configuring of technological functions both for the SIMOTION motion control system as well as for the SINAMICS drive system. This provides the user with a new dimension of system adaptability for specific machine functions.

DCC does not restrict the number of functions that can be used; the only restriction is the performance of the target platform.

The user-friendly DCC editor enables easy graphical configuration and a clear representation of control loop structures as well as a high degree of reusability of existing diagrams.

The open-loop and closed-loop control functionality is defined by using multi-instance-enabled blocks (Drive Control Blocks (DCBs)) from a pre-defined library (DCB library) that are selected and graphically linked by dragging and dropping.

Test and diagnostic functions allow verification of the program behavior, and troubleshooting in the event of a fault.

The block library encompasses a large selection of closed-loop, arithmetic and logic function blocks, as well as comprehensive open-loop and closed-loop control functions.

For combining, analyzing and acquiring binary signals, all commonly used logic functions are available for selection (AND, XOR, on/off delay, RS flipflop, counter, etc.). Numerous computation functions are available for monitoring and evaluating numerical variables; for example absolute value generation, division, min/max evaluation.

Besides drive control functions, it is also a simple matter to configure axis winding functions, PI controllers, ramp-function generators, and wobble generators.

Almost unlimited programming of control structures is possible in conjunction with the SIMOTION motion control system. These can then be combined with other program sections to form an overall program.

Drive Control Chart for SINAMICS also provides a convenient basis for resolving drive-level open-loop and closed-loop control tasks directly in the converter. This results in further adaptability of SINAMICS for the tasks set. On-site processing in the drive supports modular machine concepts and results in increased overall machine performance.

Note

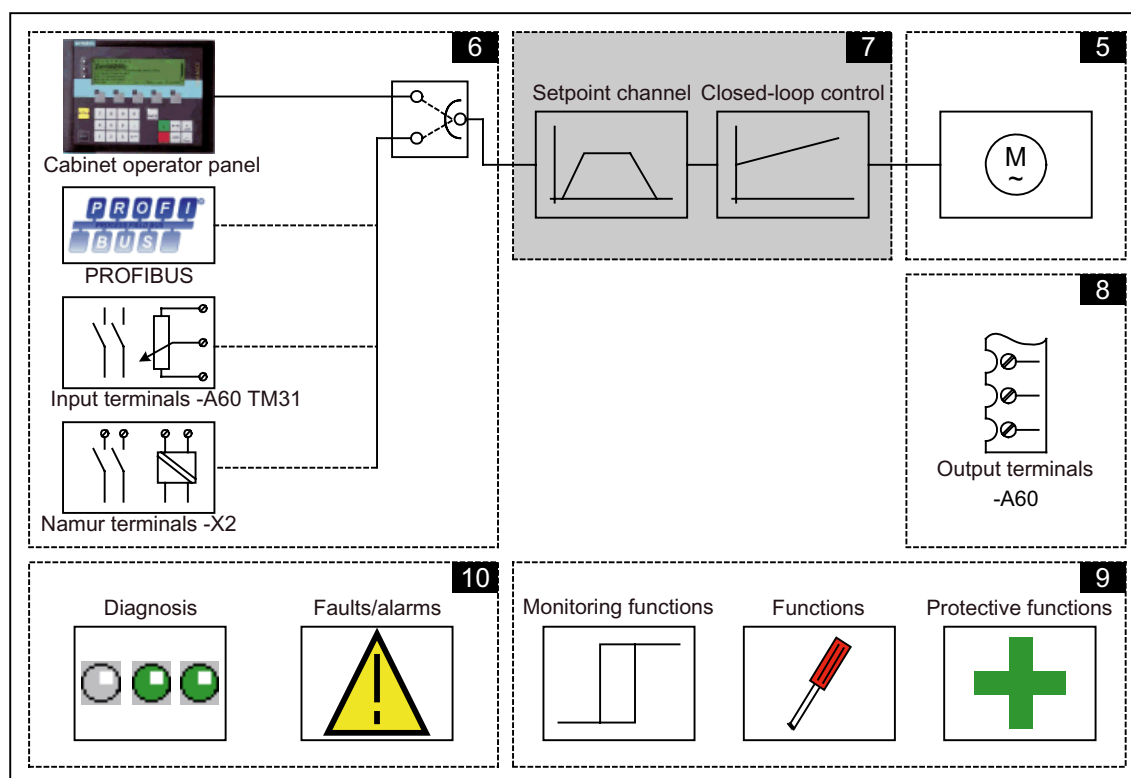
A detailed description of the DCC Editor and the available Drive Control Blocks is given in the relevant documentation. This documentation is available on the accompanying customer CD.

Setpoint channel and closed-loop control

7.1 Chapter content

This chapter provides information on the setpoint channel and closed-loop control functions.

- Setpoint channel
 - Direction reversal
 - Skip speed
 - Minimum speed
 - Speed limitation
 - Ramp-function generator
- V/f control
- Speed control with / without encoder



Function diagrams

To supplement these operating instructions, the documentation folder contains simplified function diagrams describing the operating principle.

The diagrams are arranged in accordance with the chapters in the operating instructions. The page numbers (7xx) describe the functionality in the following chapter.

At certain points in this chapter, reference is made to function diagrams with a 4-digit number. These can be found on the documentation CD in the "SINAMICS List Manual", which provides experienced users with detailed descriptions of all the functions.

7.2 Setpoint channel

7.2.1 Setpoint addition

Description

The supplementary setpoint can be used to enter correction values from higher-level closed-loop controls. This can be implemented using the summing point of the main/supplementary setpoint in the setpoint channel. Both variables are imported simultaneously via two separate or one setpoint source and added in the setpoint channel.

Function diagram

FD 3030 Main/added setpoint, setpoint scaling, jogging

Parameters

- p1070 Main setpoint
- p1071 Main setpoint scaling
- r1073 Main setpoint effective
- p1075 Supplementary setpoint
- p1076 Supplementary setpoint scaling
- r1077 Supplementary setpoint effective
- r1078 Total setpoint effective

7.2.2 Direction of rotation changeover

Description

Due to the direction reversal in the setpoint channel the drive can be operated in both directions with the same setpoint polarity.

Use the p1110 or p1111 parameter to block negative or positive direction of rotation.

Note

If an incorrect rotating field was connected when the cables were installed, and the rotating field cannot be corrected by swapping the motor cables, it can be corrected when commissioning the drive via p1821 (rotating field direction reversal) by changing the rotating field and thus enabling a direction reversal (see section "Direction reversal").

Prerequisites

Direction of rotation changeover is triggered:

- via PROFIBUS by means of control word 1, bit 11
- via the cabinet operator panel (LOCAL mode) with the "direction of rotation changeover" key.

Note

Note that only one direction of rotation is enabled in the factory setting when control is carried out via the AOP30.

Function diagram

FP 3040 Direction of rotation limiting and direction of rotation changeover

Parameter

- p1110 Inhibit negative direction
- p1111 Inhibit positive direction
- p1113 Direction reversal

7.2.3 Skip speeds and minimum speeds

Description

Variable-speed drives can generate critical whirling speeds within the control range of the entire drive train. This prevents steady-state operation in their proximity; in other words, although the drive can pass through this range, it must not remain within it because resonant oscillations may be excited. The skip frequency bands allow this range to be blocked for steady-state operation. Because the points at which critical whirling speeds occur in a drive train can vary depending on age or thermal factors, a broader control range must be blocked. To ensure that the speed does not constantly increase and decrease in the suppression bandwidth (speeds), the bands are assigned a hysteresis.

Specifying a minimum speed allows a specific range to be disabled around speed 0 rpm for steady-state operation.

Signal flow diagram

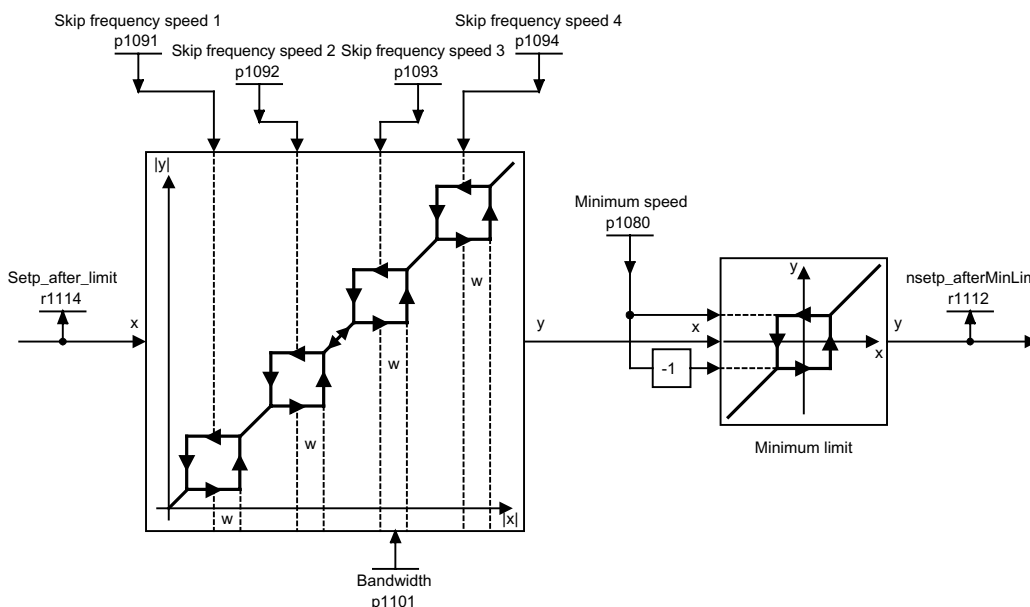


Figure 7-1 Signal flow diagram: Skip frequency speeds and minimum speeds

Function diagram

FP 3050 Skip frequency bands and speed limiting

Parameter

- p1080 Minimum speed
- p1091 Skip frequency speed 1
- p1092 Skip frequency speed 2
- p1093 Skip frequency speed 3
- p1094 Skip frequency speed 4
- p1101 Skip frequency speed bandwidth
- r1112 Speed setpoint after minimum limiting

7.2.4 Speed limitation

Description

Speed limitation aims to limit the maximum permissible speed of the entire drive train to protect the drive and load machine/process against damage caused by excessive speeds.

Signal flow diagram

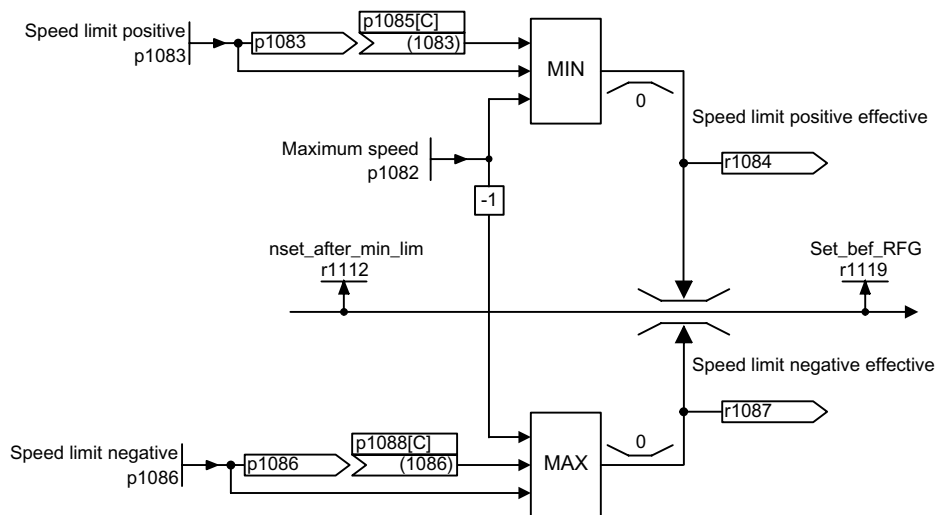


Figure 7-2 Signal flow diagram: Speed limitation

Function diagram

FP 3050 Skip frequency bands and speed limiting

Parameter

- p1082 Maximum speed
- p1083 CO: Speed limit in positive direction of rotation
- r1084 CO: Speed limit positive effective
- p1085 CI: Speed limit in positive direction of rotation
- p1086 CO: Speed limit in negative direction of rotation
- r1087 CO: Speed limit negative effective
- p1088 CI: Speed limit in negative direction of rotation

7.2.5 Ramp-function generator

Description

The ramp-function generator limits the rate at which the setpoint changes when the drive is accelerating or decelerating. This prevents excessive setpoint step changes from damaging the drive train. Additional rounding times can also be set in the lower and upper speed ranges to improve control quality and prevent load surges, thereby protecting mechanical components, such as shafts and couplings.

The ramp-up and ramp-down times each refer to the maximum speed (p1082). The rounding times that can be set can prevent the actual speed value from being overshoot when the setpoint is approached, thereby improving control quality.

Notice: if rounding times are too long, this can cause the setpoint to be overshoot if the setpoint is reduced abruptly during ramp-up. Rounding is also effective in the zero crossover; in other words, when the direction is reversed, the ramp-function generator output is reduced to zero via initial rounding, the ramp-down time, and final rounding before the new, inverted setpoint is approached via start rounding, the ramp-up time, and end rounding. Rounding times that can be set separately are active in the event of a fast stop (OFF3). The actual ramp-up/ramp-down times increase with active rounding.

The rounding type can be set using p1134 and separately activated/deactivated using p1151.0 in the zero point.

Signal flow diagram

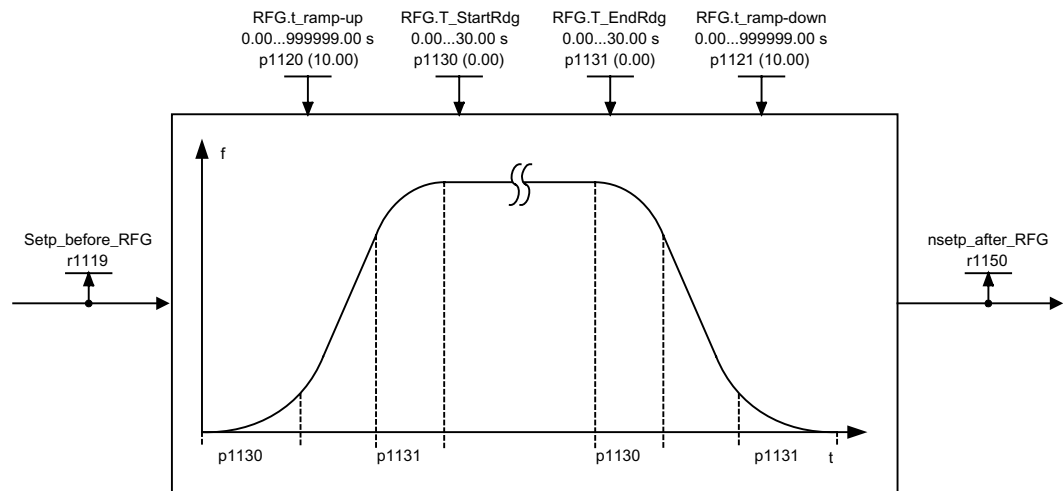


Figure 7-3 Signal flow diagram: Ramp-function generator

Function diagram

FP 3060	Simple ramp-function generator
FP 3070	Extended ramp-function generator

Parameter

- r1119 Ramp-function generator setpoint at the input
- p1120 Ramp-function generator ramp-up time
- p1121 Ramp-function generator ramp-down time
- p1130 Ramp-function generator initial rounding time
- p1131 Ramp-function generator final rounding time
- p1134 Ramp-function generator rounding type
- p1135 OFF3 ramp-down time
- p1136 OFF3 initial rounding time
- p1137 OFF3 final rounding time
- r1150 Ramp-function generator speed setpoint at the output
- p1151 Ramp-function generator configuration

Note

The effective ramp-up time increases when you enter initial and final rounding times.

Effective ramp-up time = $p1120 + (0.5 \times p1130) + (0.5 \times p1131)$

7.3 V/f control

Description

The simplest solution for a control procedure is the V/f characteristic, whereby the stator voltage for the induction motor or synchronous motor is controlled proportionately to the stator frequency. This method has proved successful in a wide range of applications with low dynamic requirements, such as:

- Pumps and fans
- Belt drives
- Multi-motor drives

V/f control aims to maintain a constant flux (Φ) in the motor, whereby the flux is proportional to the magnetization current (I_μ) or the ratio of voltage (U) to frequency (f).

$$\Phi \sim I_\mu \sim U/f$$

The torque (M) generated by the induction motors is, in turn, proportional to the product (or, more precisely, the vector product ($\Phi \times I$)) of the flux and current.

$$M \sim \Phi \times I$$

To generate as much torque as possible with a given current, the motor must function using the greatest possible constant flux. To maintain a constant flux (Φ), therefore, the voltage (V) must change in proportion to the frequency (f) to ensure a constant magnetization current (I_μ). V/f characteristic control is derived from these basic premises.

The field-weakening range is above the rated motor frequency, where the maximum voltage is reached. The flux and maximum torque decrease as the frequency increases; this is illustrated in the following diagram.

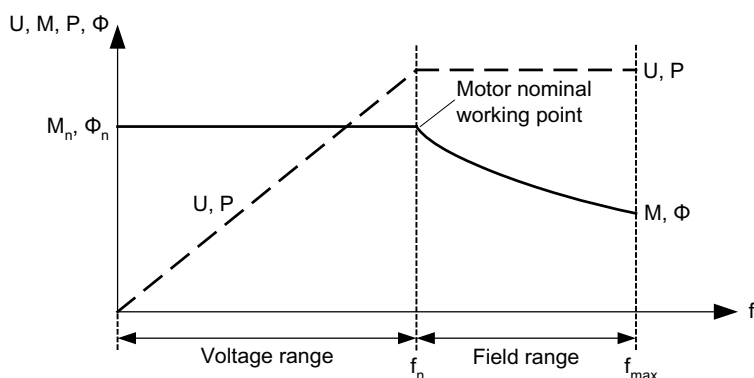
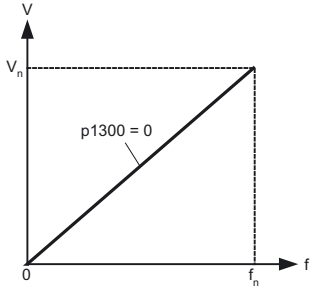
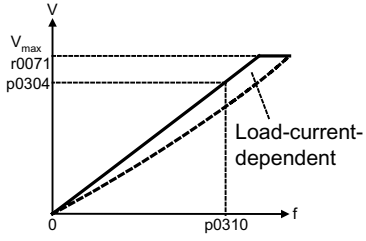
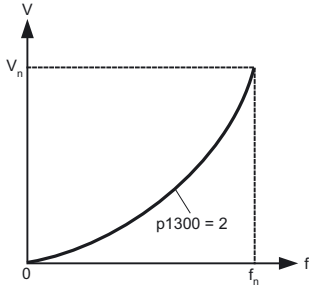
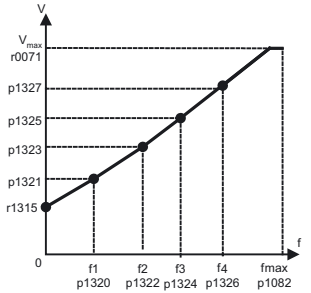


Figure 7-4 Operating areas and characteristic curves for the induction motor with converter supply

Several variations of the V/f characteristic exist, which are listed in the following table.

Table 7- 1 p1300 V/f characteristics

Parameter value	Meaning	Application / property
0	Linear characteristic	Standard with variable voltage boost 
1	Linear characteristic with flux current control (FCC)	Characteristic that compensates for voltage losses in the stator resistance for static / dynamic loads (flux current control FCC). This is particularly useful for small motors, since they have a relatively high stator resistance. 
2	Parabolic characteristic	Characteristic that takes into account the motor torque curve (e.g. fan/pump). <ul style="list-style-type: none"> • Quadratic characteristic (f² characteristic) • Energy saving because the low voltage also results in small currents and losses. 
3	Programmable characteristic	Characteristic that takes into account the motor/machine torque characteristic. 
5	Precise frequency drives (textiles)	Characteristic (see parameter value 0) that takes into account the technological particularity of an application (e.g. textile applications): <ul style="list-style-type: none"> • Whereby current limitation (Imax controller) only affects the output voltage and not the output frequency. • By disabling slip compensation and resonance damping

7.3 V/f control

Parameter value	Meaning	Application / property
6	Precise frequency drives with flux current control (FCC)	Characteristic (see parameter value 1) that takes into account the technological particularity of an application (e.g. textile applications): <ul style="list-style-type: none"> • Whereby current limitation (Imax controller) only affects the output voltage and not the output frequency. • By disabling slip compensation and resonance damping Voltage losses in the stator resistance for static / dynamic loads are also compensated (flux current control FCC). This is particularly useful for small motors, since they have a relatively high stator resistance.
19	Independent voltage setpoint	The user can define the output voltage of the Power Module independently of the frequency using BICO parameter p1330 via the interfaces (e.g., analog input AI0 of the TM31 -> p1330 = r4055[0]).

Function diagram

FP 6300 V/f characteristic and voltage boost

Parameter

- p1300 Open-loop/closed-loop control operating mode

7.3.1 Voltage boost

Description

With low output frequencies, the V/f characteristics yield only a small output voltage.

With low frequencies, too, the ohmic resistance of the stator windings has an effect and can no longer be ignored vis-à-vis the machine reactance. With low frequencies, therefore, the magnetic flux is no longer proportional to the magnetization current or the V/f ratio.

The output voltage may, however, be too low to:

- Magnetize the induction motor.
- Maintain the load.
- Compensate for the voltage losses (ohmic losses in the winding resistors) in the system.
- Induce a breakaway / accelerating / braking torque.

You can choose whether the voltage boost is to be active permanently (p1310) or only during acceleration (p1311).

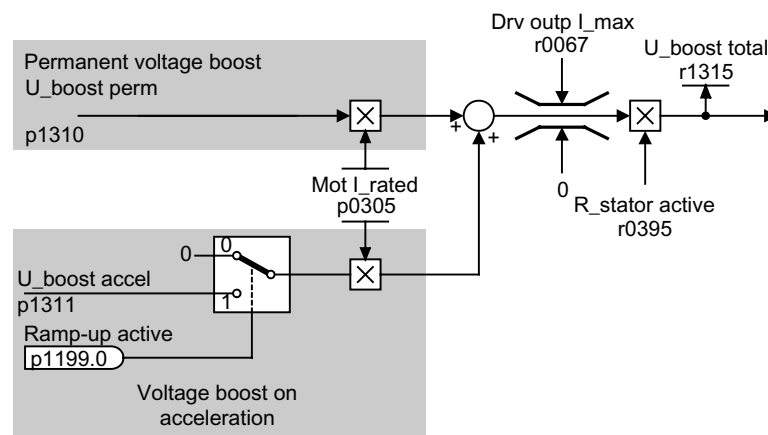


Figure 7-5 Voltage boost total

Note

The voltage boost affects all V/f characteristics (p1300) from 0 to 6.

NOTICE

If the voltage boost value is too high, this can result in a thermal overload of the motor winding.

Permanent voltage boost (p1310)

The voltage boost is active across the entire frequency range up to the rated frequency f_n , whereby the value decreases continuously at higher frequencies.

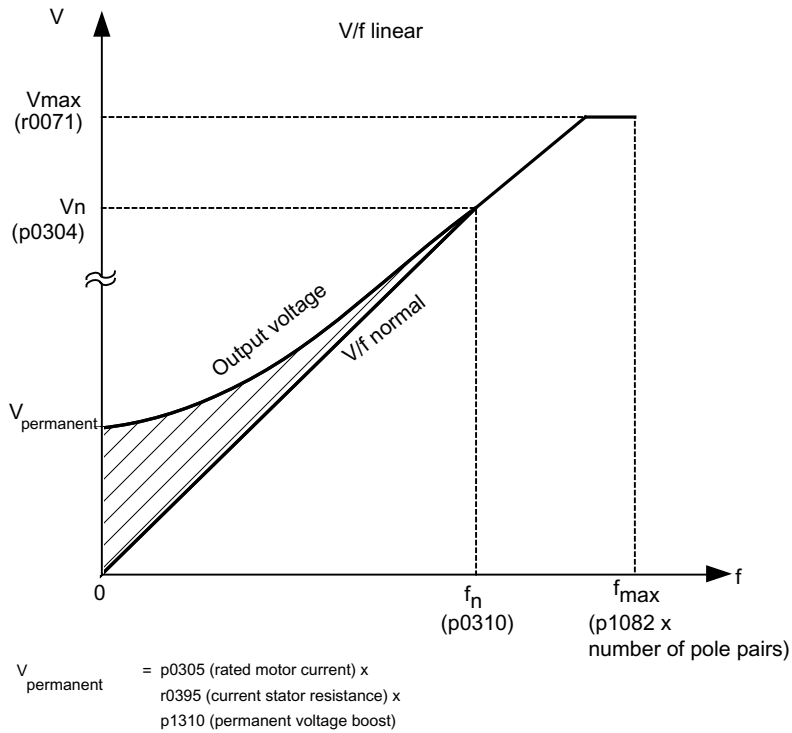


Figure 7-6 Permanent voltage boost (example: p1300 = 0, p1310 >0, p1311 = 0)

Voltage boost during acceleration (p1311)

Voltage boost is only active during acceleration or braking. Voltage boost is only active if the "Ramp-up active" signal (r1199.0 = 1) or "Ramp-down active" (r1199.1 = 1) is pending.

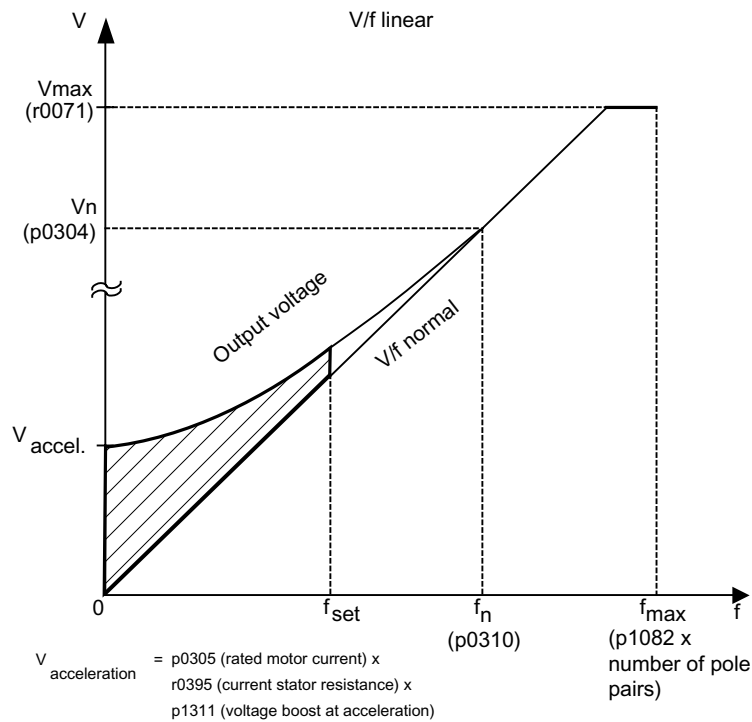


Figure 7-7 Voltage boost during acceleration (example: p1300 = 0, p1310 = 0, p1311 > 0)

Function diagram

FP 6300 V/f characteristic and voltage boost

Parameter

- p0304 Rated motor voltage
- p0305 Rated motor current
- r0395 Stator resistance, actual
- p1310 Permanent voltage boost
- p1311 Voltage boost during acceleration
- r1315 Voltage boost total

7.3.2 Slip compensation

Description

The slip compensation means that the speed of induction motors is essentially kept constant independent of the load.

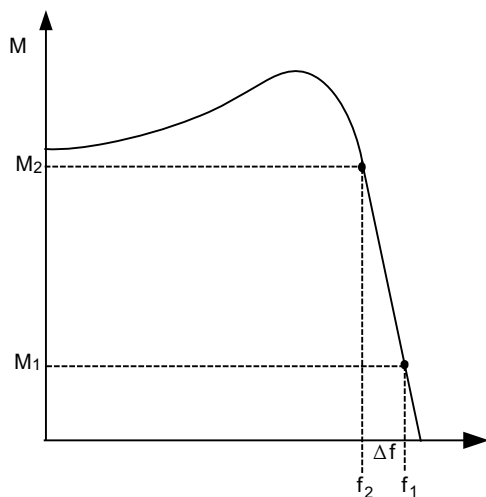


Figure 7-8 Slip compensation

Function diagram

FP 6310 Resonance damping and slip compensation

Parameters

- p1335 Slip compensation
p1335 = 0.0 %: slip compensation is deactivated.
p1335 = 100.0 %: slip is fully compensated.
- p1336 Slip compensation limit value
- r1337 Actual slip compensation

7.4 Vector speed/torque control with/without encoder

Description

Compared with V/f control, vector control offers the following benefits:

- Stability vis-à-vis load and setpoint changes
- Short rise times with setpoint changes (→ better command behavior)
- Short settling times with load changes (→ better disturbance characteristic)
- Acceleration and braking are possible with maximum adjustable torque
- Motor protection due to variable torque limitation in motor and regenerative mode
- Drive and braking torque controlled independently of the speed

These benefits are available without speed feedback.

Vector control can be used with or without an encoder.

The following criteria indicate when an encoder is required:

- Maximum speed accuracy requirements
- Maximum dynamic response requirements
 - Better command behavior
 - Shortest settling times when disturbances occur
- Torque control is required in a control range greater than 1:10
- Allows a defined and/or variable torque for speeds below approx. 10% of the rated motor frequency (p0310) to be maintained.
- A speed controller is normally always required for applications in which an unknown speed can represent a safety risk (where a load can be dropped, e.g. lifting gear, elevators, etc).

With regard to setpoint input, vector control is divided into:

- Speed control
- Torque/current control (in short: torque control)

7.4.1 Vector control without encoder

Description

For sensorless vector control only (SLVC: Sensorless Vector Control), the position of the flux and actual speed must be determined via the electric motor model. The model is buffered by the incoming currents and voltages. At low frequencies (approx. 0 Hz), the model cannot determine the speed.

For this reason and due to uncertainties in the model parameters or inaccurate measurements, the system is switched from closed-loop to open-loop operation in this range.

The changeover between closed-loop/open-loop operation is controlled on the basis of time and frequency conditions (p1755, p1756, p1758 - only for induction motors). The system does not wait for the time condition to elapse if the setpoint frequency at the ramp-function generator input and the actual frequency are below $p1755 \times (1 - (p1756 / 100 \%)$ simultaneously.

Transition from open-loop to closed-loop operation always takes place when the changeover speed in p1755 (characteristic "1" in the figure below). If the speed increase is set very slow and a changeover delay time >0 is set in p1759, transition takes place after the changeover delay time (characteristic "2" in the figure below).

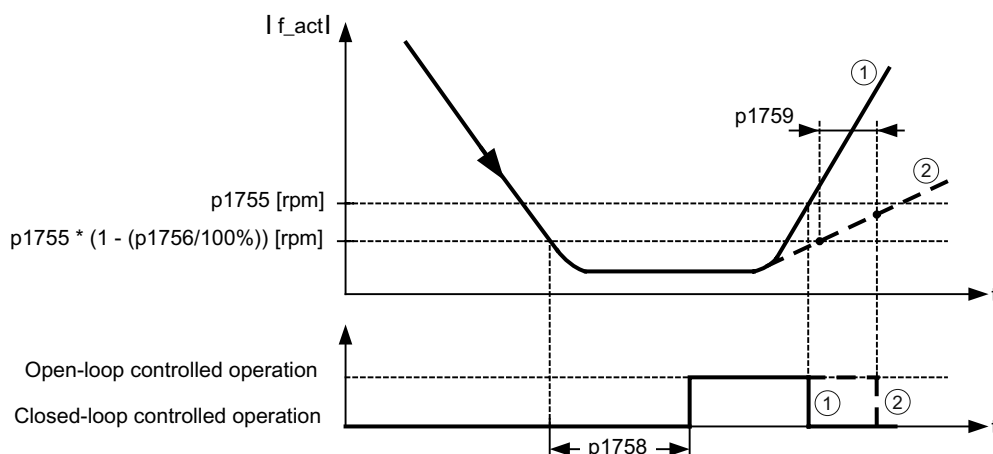


Figure 7-9 Changeover conditions

In open-loop operation, the calculated actual speed value is the same as the setpoint value. For vertical loads and acceleration processes, parameters p1610 (constant torque boost) and p1611 (acceleration torque boost) must be modified in order to generate the static or dynamic load torque of the drive. If, on induction motors, p1610 is set to 0%, only the magnetizing current r0331 is injected; at a value of 100%, the rated motor current p0305 is injected. For permanent-magnet synchronous motors, at p1610 = 0%, a pre-control absolute value derived from the supplementary torque r1515 remains instead of the magnetizing current. To ensure that the drive does not stall during acceleration, p1611 can be increased or acceleration pre-control for the speed controller can be used. This is also advisable to ensure that the motor is not subject to thermal overload at low speeds.

Vector control without a speed sensor has the following characteristics at low frequencies:

- Closed-loop operation up to approx. 1 Hz output frequency
- Starting in closed-loop operation (directly after the drive has been energized) (induction motors only)

Note

In this case, the speed setpoint upstream of the ramp-function generator must be greater than the changeover speed in p1755.

Closed-loop operation up to approx. 1 Hz (settable via parameter p1755) and the ability to start or reverse at 0 Hz directly in closed-loop operation (settable via parameter p1750) result in the following benefits:

- No changeover required within closed-loop control (smooth operation, no dips in frequency).
- Stationary speed–torque control up to approx. 1 Hz.

Note

When the motor is started or reversed in closed-loop control at 0 Hz, it is important to take into account that a switchover is made from closed-loop to open-loop control automatically if the system remains in the 0 Hz range for too long (> 2 s or > p1758, if p1758 > 2 s).

Permanent-magnet synchronous motors are always started and reversed in open-loop operation. The changeover speeds are set to 10% or 5% of the rated motor speed. Changeover is not subject to any time condition (p1758 is not evaluated). Prevailing load torques (motor or regenerative) are adapted in open-loop operation, facilitating constant-torque crossover to closed-loop operation even under high static loads. Whenever the pulses are enabled, the rotor position is identified.

Closed-loop operation down to standstill for passive loads

By restricting to a passive load at the starting point, it is possible to maintain stationary closed-loop operation down to zero frequency (standstill) without having to change over to open-loop operation.

Parameter p1750.2 must be set to 1.

Closed-loop control without changeover is restricted to applications with passive load: These include applications in which the load cannot produce a regenerative torque on startup and the motor comes to a standstill when pulses are inhibited; for example, moments of inertia, brakes, pumps, fans, centrifuges, extruders, etc.

Standstill of any duration is possible without holding current, only the motor magnetization current is impressed.

The stationary regenerating operation at a frequency close to zero is not permissible.

It is also possible to select sensorless control for passive loads during commissioning by setting p0500 = 2 (technology application = passive loads (for sensorless control down to $f = 0$)).

This function is activated automatically if quick commissioning is exited with p3900 > 0, or if automatic calculation is called (p0340 = 1, 3, 5 or p0578 = 1).

Function diagram

FP 6730 Interface to Motor Module

Parameter

- p0305 Rated motor current
- r0331 Motor magnetizing current/short-circuit current
- p0500 Technology application
- p0578 Calculating technology/unit-dependent parameters
- p1610 Torque setpoint static (SLVC)
- p1611 Supplementary accelerating torque (SLVC)
- p1750 Motor model configuration
- p1755 Motor model changeover speed encoderless operation
- p1756 Motor model changeover speed hysteresis
- p1758 Motor model changeover delay time, closed/open-loop control
- p1759 Motor model changeover delay time open/closed loop control

7.4.2 Vector control with encoder

Description

Benefits of vector control with an encoder:

- The speed can be controlled right down to 0 Hz (standstill)
- Stable control response throughout the entire speed range
- Allows a defined and/or variable torque for speeds below approx. 10 % of the rated motor speed to be maintained
- Compared with speed control without an encoder, the dynamic response of drives with an encoder is significantly better because the speed is measured directly and integrated in the model created for the current components.

Motor model change

A model change takes place between the current model and the observer model within the speed range $p1752 \times (100 \% - p1756)$ and $p1752$. In the current-model range (i.e., at lower speeds), torque accuracy depends on whether thermal tracking of the rotor resistance is carried out correctly. In the observer-model range and at speeds of less than approx. 20% of the rated speed, torque accuracy depends primarily on whether thermal tracking of the stator resistance is carried out correctly. If the resistance of the supply cable is greater than 20% to 30 % of the total resistance, this should be entered in $p0352$ before motor data identification is carried out ($p1900/p1910$).

To deactivate thermal adaptation, set $p0620 = 0$. This may be necessary if adaptation cannot function accurately enough due to the following supplementary conditions: For example, if a KTY sensor is not used for temperature detection and the ambient temperatures fluctuate significantly or the overtemperatures of the motor ($p0626 \dots p0628$) deviate significantly from the default settings due to the design of the motor.

Function diagram

FP 4715	Actual speed value and rotor position measurement, motor encoder
FD 6030	Speed setpoint, droop
FP 6040	Speed controller
FP 6050	Kp_n-/Tn_n adaptation
FP 6060	Torque setpoint
FP 6490	Speed control configuration

7.4.3 Speed controller

Description

Both closed-loop control techniques with and without encoder (SLVC, VC) have the same speed controller structure that contains the following components as kernel:

- PI controller
- Speed controller pre-control
- Droop Function

The torque setpoint is generated from the total of the output variables and reduced to the permissible magnitude by means of torque setpoint limitation.

The speed controller receives its setpoint (r0062) from the setpoint channel and its actual value (r0063) either directly from the speed actual value encoder (vector control with encoder) or indirectly via the motor model (encoderless vector control). The system difference is increased by the PI controller and, in conjunction with the pre-control, results in the torque setpoint.

When the load torque increases, the speed setpoint is reduced proportionately when the droop function is active, which means that the single drive within a group (two or more mechanically connected motors) is relieved when the torque becomes too great.

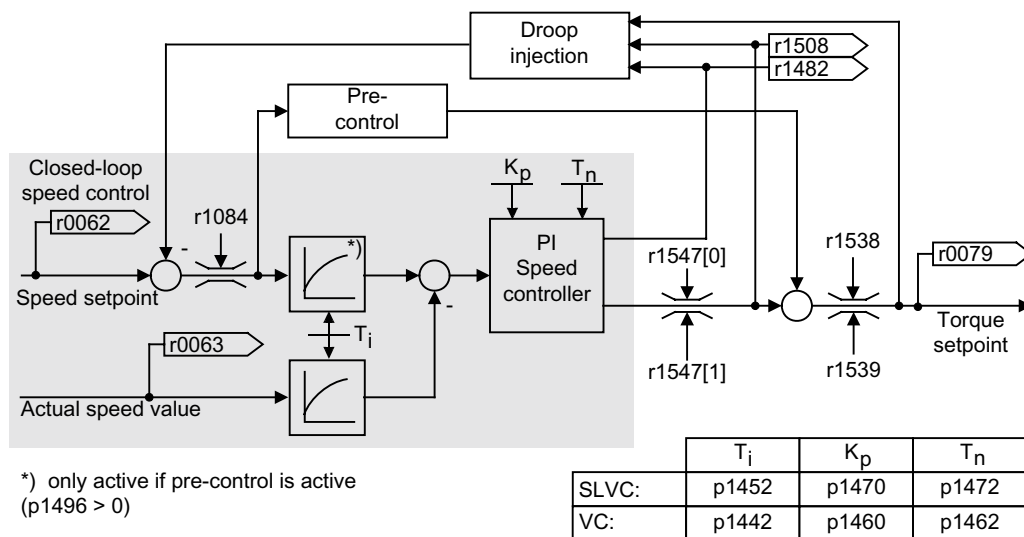


Figure 7-10 Speed controller

The optimum speed controller setting can be determined via the automatic speed controller optimization function (p1900 = 1, rotating measurement).

If the moment of inertia has been specified, the speed controller (K_p , T_n) can be calculated by means of automatic parameterization (p0340 = 4). The controller parameters are defined in accordance with the symmetrical optimum as follows:

$$T_n = 4 \times T_s$$

$$K_p = 0.5 \times r0345 / T_s = 2 \times r0345 / T_n$$

T_s = Sum of the short delay times (includes p1442 and p1452).

If vibrations occur with these settings, the speed controller gain (Kp) will need to be reduced manually. Actual-speed-value smoothing can also be increased (standard procedure for gearless or high-frequency torsion vibrations) and the controller calculation performed again because this value is also used to calculate Kp and Tn.

The following relationships apply for optimization:

- If Kp is increased, the controller becomes faster, although overshoot is increased. However, signal ripples and vibrations in the speed control loop will increase.
- Although reducing Tn will also speed up the controller, it will increase overshoot.

When setting speed control manually, you are advised to define the dynamic response via Kp (and actual-speed-value smoothing) first, so that the integral time can subsequently be reduced as much as possible. Please remember that closed-loop control must also remain stable in the field-weakening range.

To suppress any vibrations that occur in the speed controller, it is usually only necessary to increase the smoothing time in p1452 for operation without an encoder or p1442 for operation with an encoder, or reduce the controller gain.

The integral output of the speed controller can be monitored via r1482 and the limited controller output via r1508 (torque setpoint).

Note

In comparison with speed control with an encoder, the dynamic response of drives without an encoder is significantly reduced. The actual speed is derived by means of a model calculation based on the converter output variables for current and voltage that have a corresponding interference level. To this end, the actual speed must be adjusted by means of filter algorithms in the software.

Function diagram

FP 6040 Speed controller

Parameter

- r0062 CO: Speed setpoint after the filter
- r0063 CO: Actual speed value smoothed
- p0340 Automatic calculation, control parameters
- r0345 CO: Rated motor startup time
- p1442 Speed-actual-value smoothing time (VC)
- p1452 Speed-actual-value smoothing time (encoderless VC)
- p1460 Speed controller P gain with encoder
- p1462 Speed controller integral time with encoder
- p1470 Speed controller encoderless operation P gain
- p1472 Speed controller encoderless operation integral time
- r1482 CO: Torque output I speed controller
- r1508 CO: Torque setpoint before supplementary torque

- p1960 Speed controller optimization selection

7.4.3.1 Examples of speed controller settings

Examples of speed controller settings for vector control with encoders

A number of examples of speed controller settings with vector control without encoders (p1300 = 20) are provided below. These should not be considered to be generally valid and must be checked in terms of the control response required.

- **Fans (large centrifugal masses) and pumps**

Kp (p1470) = 2 ... 10

Tn (p1472) = 250 ... 500 ms

The Kp = 2 and Tn = 500 ms settings result in asymptotic approximation of the actual speed to the setpoint speed after a setpoint step change. During many simple control procedures, this is satisfactory for pumps and fans.

- **Stone mills, separators (large centrifugal masses)**

Kp (p1470) = 12 ... 20

Tn (p1472) = 500 ... 1000 ms

- **Kneader drives**

Kp (p1470) = 10

Tn (p1472) = 200 ... 400 ms

Note

We recommend checking the effective speed control gain (r1468) during operation. If this value changes during operation, Kp adaptation is being used (p1400.5 = 1). Kp adaptation can, if necessary, be deactivated or its behavior changed.

Examples of speed controller settings for vector control with encoders

A number of examples of speed controller settings with vector control with encoders (p1300 = 21) are provided below. These should not be considered to be generally valid and must be checked in terms of the control response required.

- **Positioning, lifting gear, travel drives**

Kp (p1460) = 10 ... 15

Tn (p1462) = 200 ... 400 ms (values \leq 200 ms are useful for positioning tasks in order to avoid overshooting the limit position.)

Actual value smoothing (p1442) = 4 ... 10 ms

- **Sugar centrifuge (large centrifugal masses)**

Kp (p1460) = 15 ... 22

Tn (p1462) = 500 ... 1000 ms

Actual value smoothing (p1442) = 50 ms

Note

The dynamic response may be insufficient if the specified current or torque limits are reached during acceleration or deceleration.

7.4.3.2 Speed controller pre-control (integrated pre-control with balancing)

Description

The command behavior of the speed control loop can be improved by calculating the accelerating torque from the speed setpoint and connecting it on the line side of the speed controller. This torque setpoint mv is applied to the current controller/the current controller is pre-controlled using adaptation elements directly as additive reference variable (enabled via p1496).

The torque setpoint (mv) is calculated from:

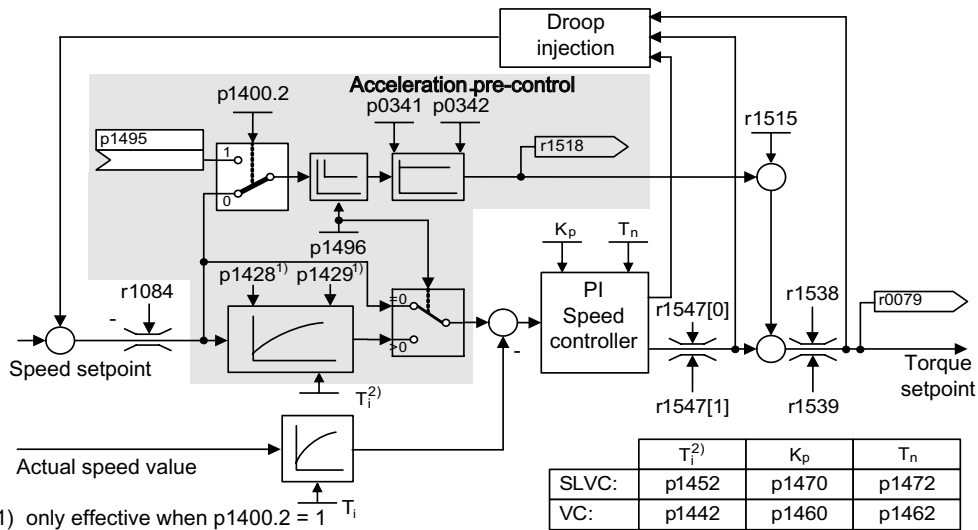
$$mv = p1496 \times J \times (d\omega/dt) = p1496 \times p0341 \times p0342 \times (d\omega/dt), \omega = 2\pi f$$

The motor moment of inertia p0341 is calculated when commissioning the drive system. The factor p0342 between the total moment of inertia J and the motor moment of inertia must be determined manually or by optimizing the speed controller.

Note

When speed controller optimization is carried out, the ratio between the total moment of inertia and that of the motor (p0342) is determined and acceleration pre-control scaling (p1496) is set to 100 %.

If p1400.2 = p1400.3 = 0, then the pre-control balancing is automatically set.



- 1) only effective when p1400.2 = 1
- 2) only effective when p1400.2 = 0

Figure 7-11 Speed controller with pre-control

When correctly adapted, when accelerating, the speed controller only has to compensate disturbance variables in its control loop. This is achieved with a relatively minor controlled variable change at the controller output.

The effect of the pre-control variable can be adapted according to the application using the weighting factor p1496. For p1496 = 100%, pre-control is calculated according to the motor and load moment of inertia (p0341, p0342). A balancing filter is used automatically to prevent the speed controller acting against the injected torque setpoint. The time constant of the balancing filter corresponds to the equivalent delay time of the speed control loop. Speed controller pre-control is correctly set (p1496 = 100%, calibration using p0342) if the I component of the speed controller (r1482) does not change while ramping-up or ramping-down in the range $n > 20\% \times p0310$. Thus, pre-control allows a new speed setpoint to be approached without overshoot (prerequisite: torque limiting does switch in and the moment of inertia remains constant).

If the speed controller is pre-controlled by means of injection, the speed setpoint (r0062) is delayed with the same smoothing time (p1442 or p1452) as the actual value (r1445). This ensures that no target/actual difference (r0064) occurs at the controller input during acceleration, which would be attributable solely to the signal propagation time.

When speed pre-control is activated, the speed setpoint must be specified continuously or without a higher interference level (avoids sudden torque changes). An appropriate signal can be generated by smoothing the speed setpoint or activating ramp-function generator rounding p1130 – p1131.

The startup time r0345 ($T_{startup}$) is a measure for the total moment of inertia J of the machine and describes the time during which the unloaded drive can be accelerated with the rated motor torque r0333 ($M_{mot, rated}$) from standstill to the rated motor speed p0311 ($n_{mot, rated}$).

$$r0345 = T_{startup} = J \times (2 \times \pi \times n_{mot, rated}) / (60 \times M_{mot, rated}) = p0341 \times p0342 \times (2 \times \pi \times p0311) / (60 \times r0333)$$

The ramp-up and ramp-down times should always be set to values larger than the startup time.

Note

The ramp-up and ramp-down times (p1120; p1121) of the ramp-function generator in the setpoint channel should be set accordingly so that the motor speed can track the setpoint during acceleration and braking. This will optimize the function of speed controller pre-control.

Acceleration pre-control using a connector input (p1495) is activated by the parameter settings p1400.2 = 1 and p1400.3 = 0. p1428 (dead time) and p1429 (time constant) can be set for balancing purposes.

Function diagram

FP 6031 Pre-control balancing reference/acceleration model

Parameter

- p0311 Rated motor speed
- r0333 Rated motor torque
- p0341 Motor moment of inertia
- p0342 Ratio between the total and motor moment of inertia
- r0345 Rated motor startup time
- p1400.2 Acceleration pre-control source
- p1428 Speed pre-control balancing dead time
- p1429 Speed pre-control balancing time constant
- p1496 Acceleration pre-control scaling
- r1518 Acceleration torque

7.4.3.3 Reference model

Description

The reference model becomes operative when $p1400.3 = 1$ and $p1400.2 = 0$.
 The reference model is used to emulate the speed control loop with a P speed controller.
 The loop emulation can be set in $p1433$ to $p1435$. It becomes effective if $p1437$ is connected to the output of the model $r1436$.
 The reference model delays the setpoint-actual value deviation for the integral component of the speed controller so that settling (stabilizing) operations can be suppressed.
 The reference model can also be externally emulated and the external signal entered via $p1437$.

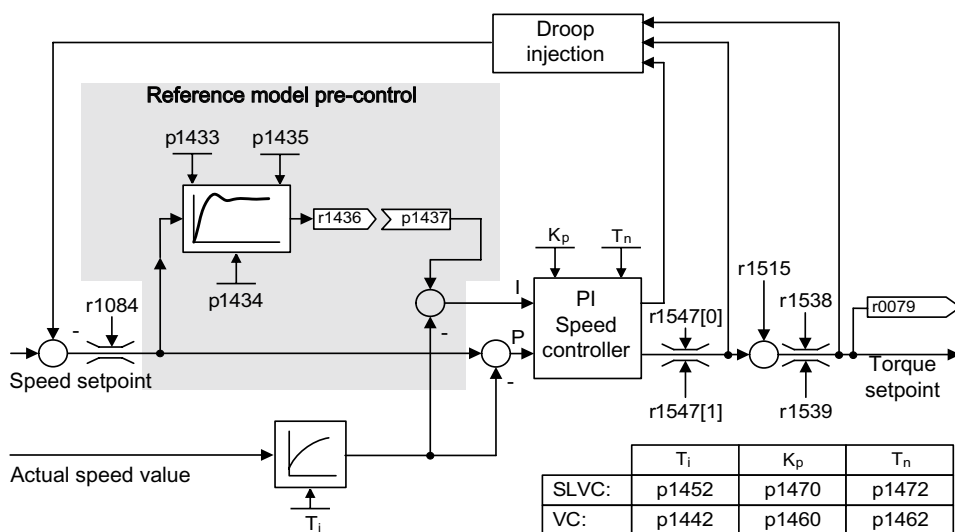


Figure 7-12 Reference model

Function diagram

FP 6031 Pre-control balancing reference/acceleration model

Parameters

- $p1400.3$ Reference model speed setpoint I component
- $p1433$ Speed controller reference model natural frequency
- $p1434$ Speed controller reference model damping
- $p1435$ Speed controller reference model dead time
- $r1436$ Speed controller reference model speed setpoint output
- $p1437$ Speed controller reference model I component input

7.4.3.4 Speed controller adaptation

Description

Two adaptation methods are available, namely free Kp_n adaptation and speed-dependent Kp_n/Tn_n adaptation.

Free Kp_n adaptation is also active in "operation without encoder" mode and is used in "operation with encoder" mode as an additional factor for speed-dependent Kp_n adaptation.

Speed-dependent Kp_n/Tn_n adaptation is only active in "operation with encoder" mode and also affects the Tn_n value.

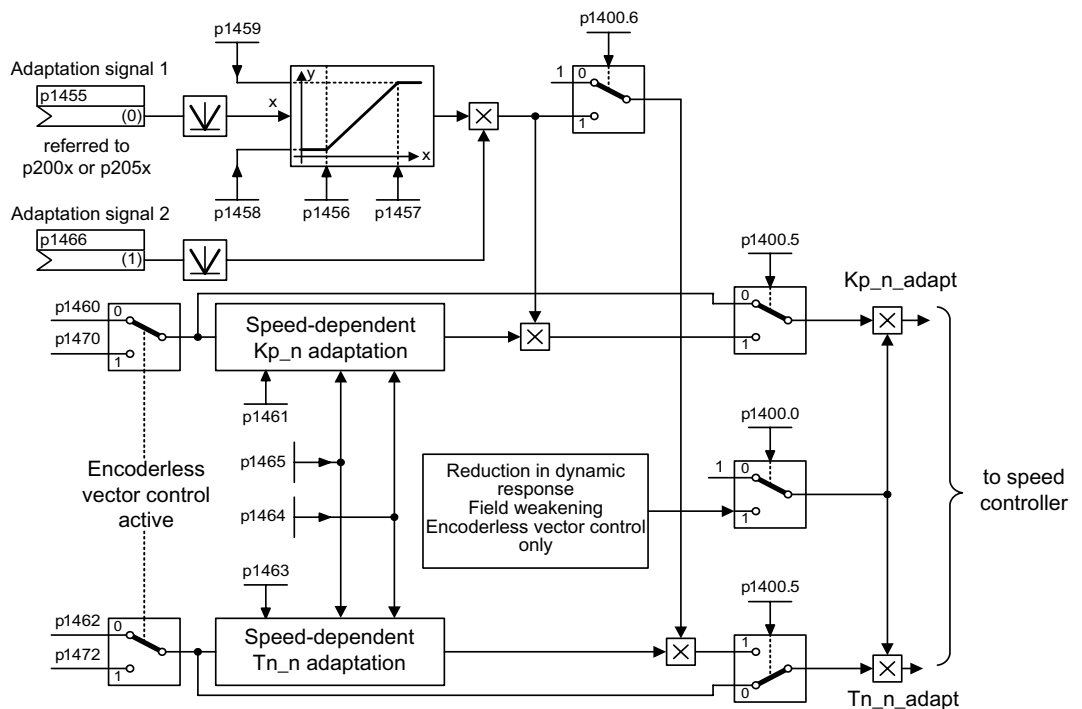


Figure 7-13 Free Kp adaptation

A dynamic response reduction in the field-weakening range can be activated in encoderless operation (p1400.0). This is activated when the speed controller is optimized in order to achieve a greater dynamic response in the base speed range.

Example of speed-dependent adaptation

Note

This type of adaptation is only active in "operation with encoder" mode.

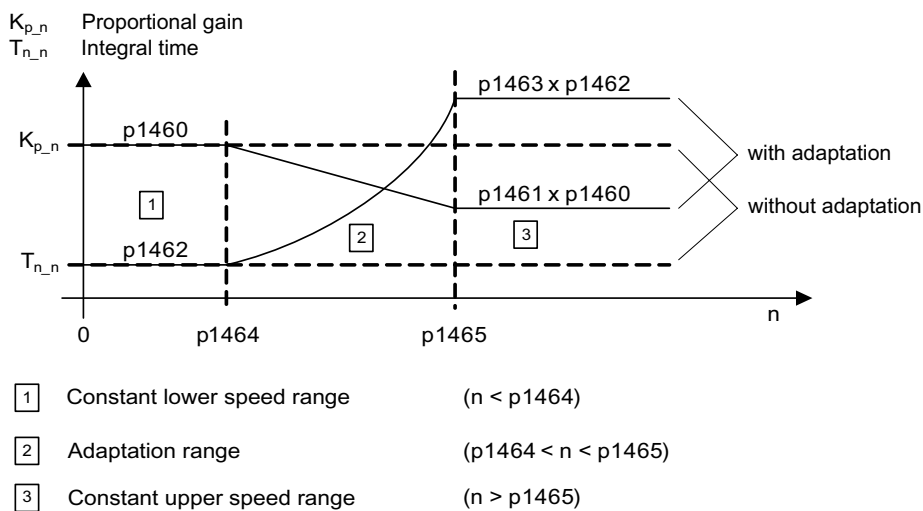


Figure 7-14 Example of speed-dependent adaptation

Function diagram

FP 6050 K_{p_n}/T_{n_n} adaptation

Parameters

- p1400.5 Speed control configuration: Kp/Tn adaptation active

Free K_{p_n} adaptation

- p1455 Speed controller P gain adaptation signal
- p1456 Speed controller P gain adaptation lower starting point
- p1457 Speed amplifier P gain adaptation upper starting point
- p1458 Adaptation factor lower
- p1459 Adaptation factor upper
- p1470 Speed controller encoderless operation P gain

Speed-dependent K_{p_n}/T_{n_n} adaptation (VC only)

- p1460 Speed controller P gain adaptation speed lower
- p1461 Speed controller P gain adaptation speed upper
- p1462 Speed controller integral time adaptation speed lower
- p1463 Speed controller integral time adaptation speed upper
- p1464 Speed controller adaptation speed lower
- p1465 Speed controller adaptation speed upper
- p1466 Speed controller P gain scaling

Dynamic response reduction field weakening (encoderless VC only)

- p1400.0 Speed control configuration: Automatic Kp/Tn adaptation active

7.4.3.5 Droop Function

Description

Droop (enabled via p1492) ensures that the speed setpoint is reduced proportionally as the load torque increases.

The droop function has a torque limiting effect on a drive that is mechanically coupled to a different speed (e.g. guide roller on a goods train). In this way, a very effective load distribution can also be realized in connection with the torque setpoint of a leading speed-controlled drive. In contrast to torque control or load distribution with overriding and limitation, with the appropriate setting, such a load distribution controls even a smooth mechanical connection.

This method is only suitable to a limited extent for drives that are accelerated and braked with significant changes in speed.

The droop feedback is used, for example, in applications in which two or more motors are connected mechanically or operate with a common shaft and fulfill the above requirements. It limits the torque differences that can occur as a result of the mechanical connection between the motors by modifying the speeds of the individual motors (drive is relieved when the torque becomes too great).

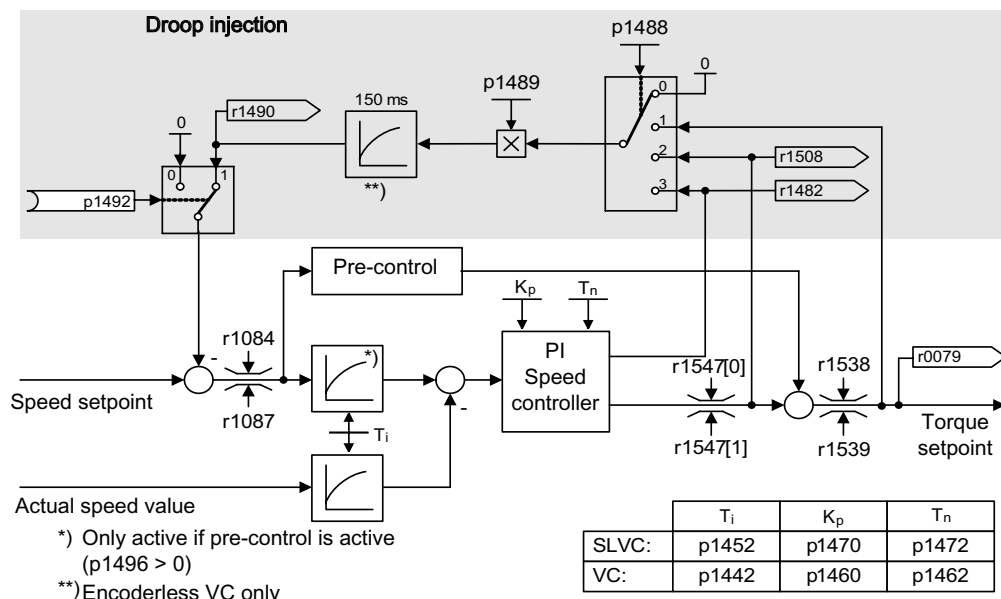


Figure 7-15 Speed controller with droop

Requirement

- All connected drives must be operated with vector and speed control (with or without speed actual value encoder).
- The setpoints at the ramp function generators of the mechanically connected drives must be identical; the ramp function generators must have identical ramp-up and ramp-down times.

Function diagram

FP 6030 Speed setpoint, droop

Parameter

- r0079 Total speed setpoint
- r1482 Speed controller I torque output
- p1488 Droop input source
- p1489 Droop feedback scaling
- r1490 Droop feedback speed reduction
- p1492 Droop feedback enable
- r1508 Torque setpoint before supplementary torque

7.4.4 Closed-loop torque control

Description

For sensorless closed-loop speed control (p1300 = 20) or closed-loop speed control with encoder VC (p1300 = 21), it is possible to change over to closed-loop torque control using BICO parameter p1501. It is not possible to change over between closed-loop speed and torque control if closed-loop torque control is directly selected with p1300 = 22 or 23. The torque setpoint and/or supplementary setpoint can be entered using BICO parameter p1503 (CI: torque setpoint) or p1511 (CI: supplementary torque setpoint). The supplementary torque acts both for closed-loop torque as well as for the closed-loop speed control. As a result of this characteristic, a pre-control torque can be implemented for the closed-loop speed control using the supplementary torque setpoint.

Note

For safety reasons, assignments to fixed torque setpoints are currently not possible.

If energy is regenerated and cannot be injected back into the line supply, then a Braking Module with connected braking resistor must be used.

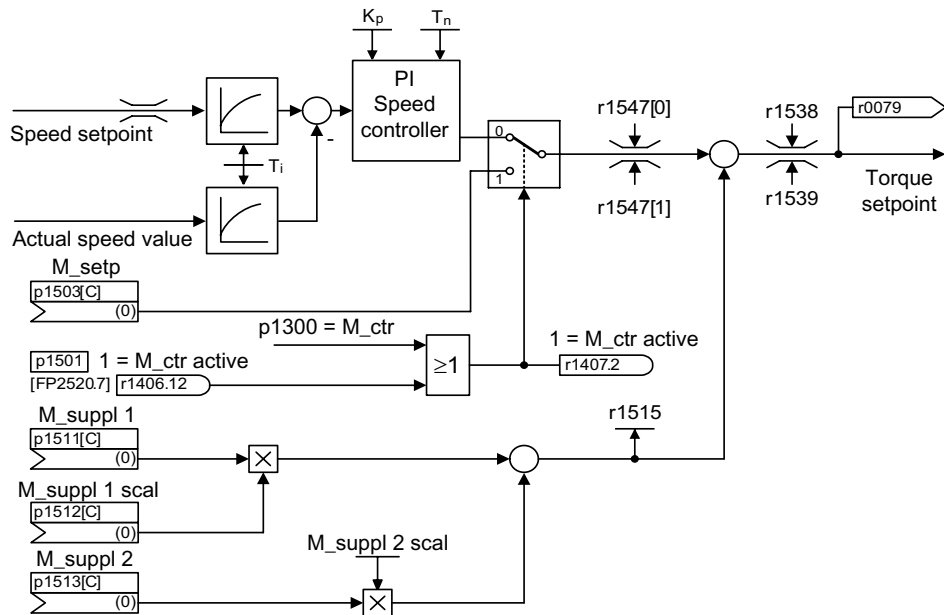


Figure 7-16 Closed-loop speed/torque control

The total of the two torque setpoints is limited in the same way as the speed control torque setpoint. Above the maximum speed (p1082), a speed limiting controller reduces the torque limits in order to prevent the drive from accelerating any further.

A "real" closed-loop torque control (with a speed that automatically sets itself) is only possible in the closed-loop control range but not in the open-loop control range of the sensorless closed-loop vector control. In the open-loop controlled range, the torque setpoint changes the setpoint speed via a ramp-up integrator (integrating time $\sim p1499 \times p0341 \times p0342$). This is the reason that sensorless closed-loop torque control close to standstill is only suitable for applications that require an accelerating torque there and no load torque (e.g. traversing drives). Closed-loop torque control with encoder does not have this restriction.

OFF responses

- OFF1 and p1300 = 22, 23
 - Response as for OFF2
- OFF1, p1501 = "1" signal and p1300 \neq 22, 23
 - No separate braking response; the braking response is provided by a drive that specifies the torque.
 - The pulses are inhibited when the brake application time (p1217) expires. Standstill is detected when the speed actual value of the speed threshold (p1226) is undershot or when the monitoring time (p1227) started when speed setpoint \leq speed threshold (p1226) expires.
 - Switching on inhibited is activated.

- OFF2
 - Immediate pulse suppression, the drive coasts to standstill.
 - The motor brake (if parameterized) is closed immediately.
 - Switching on inhibited is activated.
- OFF3
 - Switch to speed-controlled operation
 - $n_set = 0$ is input immediately to brake the drive along the OFF3 deceleration ramp (p1135).
 - When standstill is detected, the motor brake (if parameterized) is closed.
 - The pulses are inhibited when the motor brake closing time (p1217) has elapsed. Standstill is detected when the speed actual value of the speed threshold (p1226) is undershot or when the monitoring time (p1227) started when speed setpoint \leq speed threshold (p1226) expires.
 - Switching on inhibited is activated.

Function diagram

FP 6060 Torque setpoint

Parameters

- p0341 Motor moment of inertia
- p0342 Ratio between the total and motor moment of inertia
- p1300 Open-loop/closed-loop control mode
- p1499 Accelerating for torque control, scaling
- p1501 Change over between closed-loop speed/torque control
- p1503 Torque setpoint
- p1511 Supplementary torque 1
- p1512 Supplementary torque 1 scaling
- p1513 Supplementary torque 2
- p1514 Supplementary torque 2 scaling
- r1515 Supplementary torque total

7.4.5 Torque limiting

Description

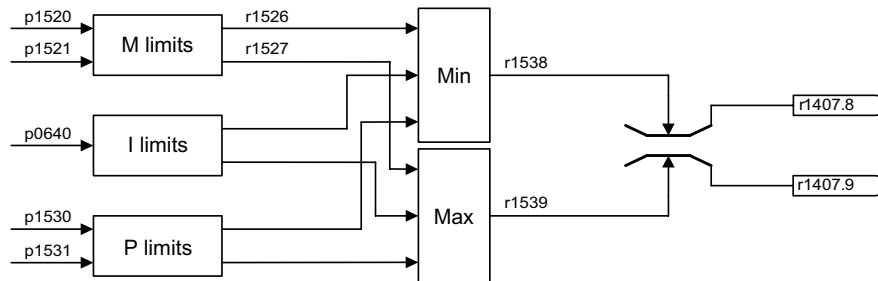


Figure 7-17 Torque limiting

The value specifies the maximum permissible torque whereby different limits can be parameterized for motor and regenerative mode.

- p0640 Current limit
- p1520 CO: Torque limit, upper/motoring
- p1521 CO: Torque limit, lower/regenerative
- p1522 CI: Torque limit, upper/motoring
- p1523 CI: Torque limit, lower/regenerative
- p1524 CO: Torque limit, upper/motoring, scaling
- p1525 CO: Torque limit, lower/regenerative scaling
- p1530 Power limit, motoring
- p1531 Power limit, regenerating

The currently active torque limit values are displayed in the following parameters:

- r0067 Maximum drive output current
- r1526 Torque limit, upper/motoring without offset
- r1527 Torque limit, lower/regenerative without offset

All of the following limits act on the torque setpoint – that is either available at the speed controller output for closed-loop speed control or as torque input, for closed-loop torque control. The minimum or the maximum is used for the various limits. This minimum or maximum is cyclically calculated and is displayed in r1538 or r1539.

- r1538 Upper effective torque limit
- r1539 Lower effective torque limit

These cyclical values therefore limit the torque setpoint at the speed controller output/torque input or indicate the instantaneous max. possible torque. If the torque setpoint is limited, then this is displayed using parameter p1407.

- r1407.8 Upper torque limit active
- r1407.9 Lower torque limit active

Function diagram

FP 6060	Torque setpoint
FP 6630	Upper/lower torque limit
FP 6640	Current/power/torque limits

7.4.6 Permanent-field synchronous motors

Description

Permanent-magnet synchronous motors that are equipped with a position encoder or a pulse encoder with zero mark are supported.

Permanent-magnet synchronous motors without encoders are also supported for operation without encoders. Controlled operation is not possible when the motor is stationary.

Typical applications include direct drives with torque motors which are characterized by high torque at low speeds, e.g. Siemens complete torque motors of the 1FW3 series. When these drives are used, gear units and mechanical parts subject to wear can be dispensed with if the application allows this.



WARNING

As soon as the motor starts to rotate, a voltage is generated. When work is carried out on the converter, the motor must be safely disconnected. If this is not possible, the motor must be locked by a holding brake, for example.

Features

- Field weakening of up to approx. 1.2 x rated speed (depending on the supply voltage of the converter and motor data, also see supplementary conditions)
- Flying restart (during operation without encoders, only when a VSM module is used to record the motor speed and phase angle (option K51))
- Speed and torque control vector
- V/f control for diagnostics vector
- Motor identification
- Automatic rotary transducer adjustment (calibration of the encoder's zero position, not for operation without encoders)
- Speed controller optimization (rotary measurement)


Supplementary conditions

- Maximum speed or maximum torque depend on the converter output voltage available and the back EMF of the motor (calculation specifications: EMF must not exceed $U_{\text{rated, converter}}$).
- Calculating the maximum speed:
$$n_{\text{max}} = n_n \cdot \sqrt{\frac{3}{2} \cdot \frac{U_{\text{DC link max}} \cdot I_n}{P_n}}$$
- Depending on the terminal voltage and load cycle, the maximum torque can be taken from the motor data sheets / configuration instructions.
- One of the following motor encoders must be used for operation with an encoder:
 - SMC10 (option K46): all resolvers that can be connected
 - SMC20 (option K48): SIN/COS encoders with C/D track, EnDat encoders
 - SMC30 (option K50): HTL/TTL encoders with zero mark.
- No thermal model is available for the closed-loop control of a permanent-magnet synchronous motor. The motor can only be protected against overheating using a temperature sensor (PTC). We recommend that the motor temperature is measured using a temperature sensor (KTY) in order to achieve a high level of torque accuracy.

Commissioning

The following sequence is recommended for commissioning:

- Configure the drive
When the drive is being commissioned using STARTER or the AOP30 operator panel, the permanent-magnet synchronous motor must be selected. The motor data specified in the table below must then be entered. Finally, the motor identification routine and speed optimization (p1900) are activated. Encoder adjustment is activated automatically together with the motor identification routine.
- Motor identification (standstill measurement, p1910)
- Encoder adjustment (p1990) (not for operation without encoder)
Motor Modules with field-oriented closed-loop control specify the current on permanent-magnet synchronous motors with regard to the magnetic flux in the motor. To this end, the motor encoder must provide information about the position of the rotor.

 WARNING
During initial commissioning and when the encoder is replaced, the encoder must be adjusted (p1990).

- Speed controller optimization (rotary measurement, p1960)

Motor data for permanent-magnet synchronous motors

Table 7- 2 Motor data type plate

Parameter	Description	Comments
p0304	Rated motor voltage	If this value is not known, the value "0" can also be entered. Entering the correct value, however, means that the stator leakage inductance (p0356, p0357) can be calculated more accurately.
p0305	Rated motor current	
p0307	Rated motor power	
p0310	Rated motor frequency	
p0311	Rated motor speed	
p0314	Motor pole pair number	If this value is not known, the value "0" can also be entered.
p0316	Motor torque constant	If this value is not known, the value "0" can also be entered.

If the torque constant k_T is not stamped on the rating plate or specified in the data sheet, you can calculate this value from the rated motor data or from the stall current I_0 and stall torque M_0 as follows:

$$k_T = \frac{M_N}{I_N} = \frac{60 \frac{s}{min} \times P_N}{2\pi \times n_N \times I_N} \quad \text{or} \quad k_T = \frac{M_0}{I_0}$$

The optional motor data can be entered if it is known. Otherwise, this data is estimated from the type plate data or determined by means of motor identification or speed controller optimization.

Table 7- 3 Optional motor data

Parameter	Description	Comments
p0320	Rated motor short-circuit current	This is used for the field weakening characteristic
p0322	Maximum motor speed	Maximum mechanical speed
p0323	Maximum motor current	De-magnetization protection
p0325	Rotor position identification current, 1st phase	-
p0327	Optional load angle	Optional otherwise leave at 90°
p0328	Reluctance torque constant	-
p0329	Rotor position identification current	-
p0341	Motor moment of inertia	For speed controller pre-control
p0344	Motor weight	-
p0350	Stator resistance, cold	-
p0356	Quadrature axis stator inductance L_q	-
p0357	In-line stator inductance L_d	-

Short-circuit protection

For short circuits that can occur in the drive converter or in the motor cable, the rotating machine would supply the short-circuit until it comes to a standstill. An output contactor can be used for protection. This should be located as close as possible to the motor. This is particularly necessary if the motor can still be driven by the load when a fault develops. The contactor must be provided with a protective circuit against overvoltage on the motor side so that the motor winding is not damaged as a result of the shutdown.

Control signal r0863.1 (VECTOR) is used to control the contactor via a free digital output; the checkback contact of the contactor is connected to parameter p0864 via a free digital input.

This means that if the drive converter develops a fault with a shutdown response, at the instant in time that the pulses are inhibited, the motor is isolated from the drive converter so that energy is not fed back to the fault location.

Function diagram

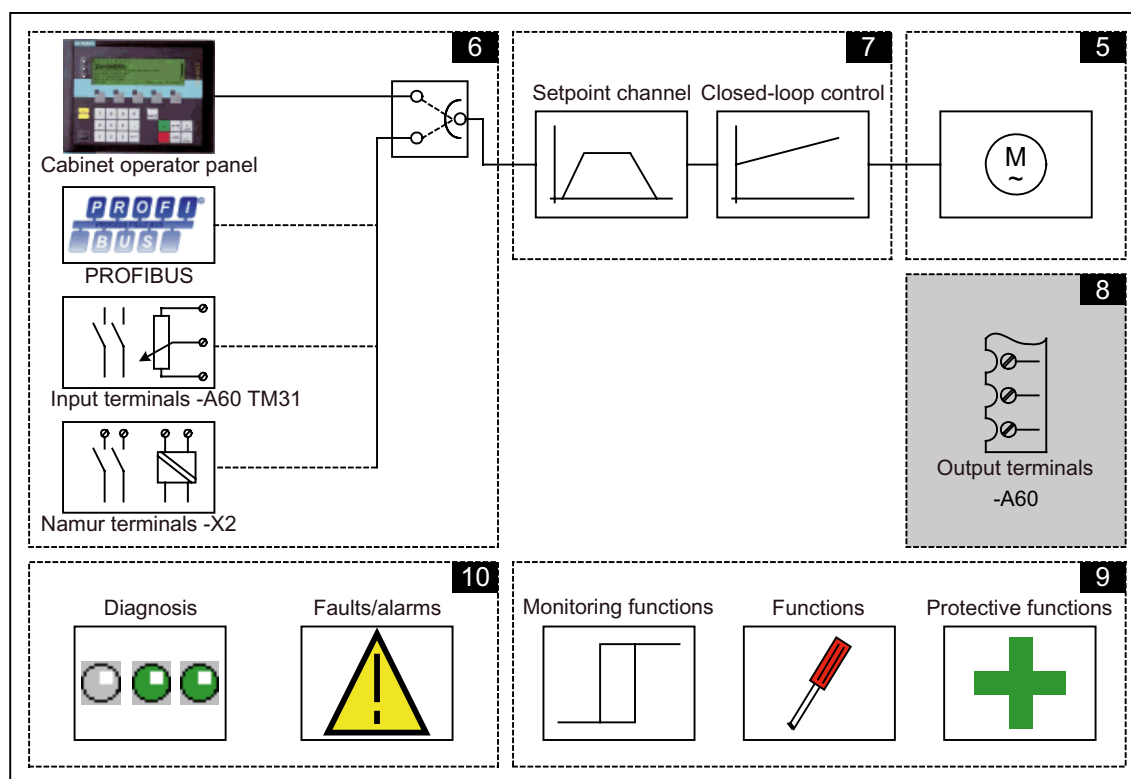
FP 4715	Actual speed value and rotor pos. meas., motor enc. ASM/SM (encoder 1)
FP 6721	Current control - Id setpoint (PEM, p0300 = 2)
FP 6724	Current control – field weakening controller (PEM, p0300 = 2)
FP 6731	Current control - interface to Motor Module (PEM, p0300 = 2)

Output terminals

8.1 Chapter content

This chapter provides information on:

- Analog outputs
- Digital outputs



Function diagrams

To supplement this operating manual, the documentation folder contains simplified function diagrams describing the operating principle.

The diagrams are arranged in accordance with the chapters in the operating manual. The page numbers (8xx) describe the functionality in the following chapter.

At certain points in this chapter, reference is made to function diagrams with a 4-digit number. These are stored on the documentation CD in the "SINAMICS List Manual", which provides experienced users with detailed descriptions of all the functions.

8.2 Analog outputs

Description

The Customer Terminal Block features two analog outputs for outputting setpoints via current or voltage signals.

Factory setting:

- AO0: Actual speed value: 0 – 20 mA
- AO1: Actual motor current: 0 – 20 mA

Signal flow diagram

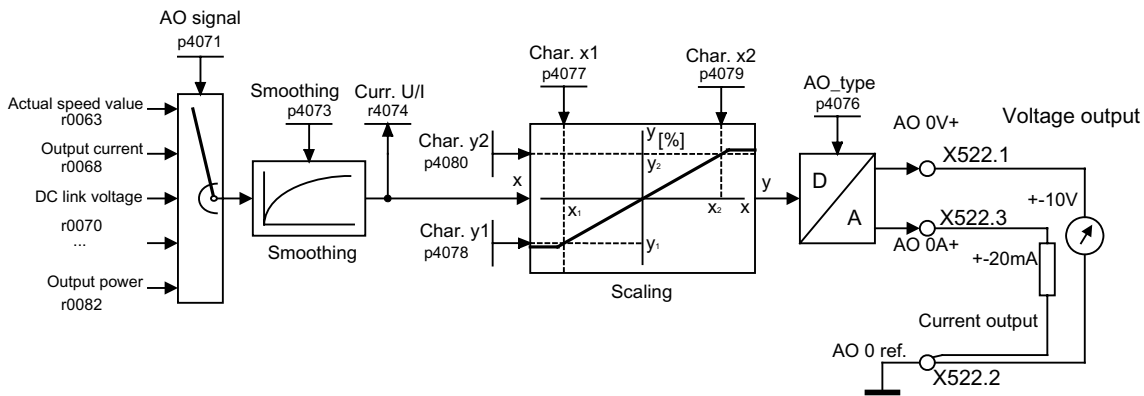


Figure 8-1 Signal flow diagram: analog output 0

Function diagram

FD 1840, TM31 - analog outputs (AO 0 ... AO 1)
FD 9572

Parameters

- p4071 Analog outputs, signal source
- p4073 Analog outputs, smoothing time constant
- r4074 Analog outputs, actual output voltage/current
- p4076 Analog outputs, type
- p4077 Analog outputs, characteristic value x1
- p4078 Analog outputs, characteristic value y1
- p4079 Analog outputs, characteristic value x2
- p4080 Analog outputs, characteristic value y2

8.2.1 Lists of signals for the analog outputs

Signals for the analog outputs: vector object

Table 8- 1 List of signals for the analog outputs - vector object

Signal	Parameter	Unit	Scaling (100 %=...) See table below
Speed setpoint before the setpoint filter	r0060	rpm	p2000
Motor speed unsmoothed	r0061	rpm	p2000
Actual speed smoothed	r0063	rpm	p2000
Output frequency	r0066	Hz	Reference frequency
Output current	r0068	Aeff	p2002
DC link voltage	r0070	V	p2001
Torque setpoint	r0079	Nm	p2003
Output power	r0082	kW	r2004
For diagnostic purposes			
Control deviation	r0064	rpm	p2000
Modulation depth	r0074	%	Reference modulation depth
Torque-generating current setpoint	r0077	A	p2002
Torque-generating actual current	r0078	A	p2002
Flux setpoint	r0083	%	Reference flux
Actual flux	r0084	%	Reference flux
For further diagnostic purposes			
Speed controller output	r1480	Nm	p2003
I component of speed controller	r1482	Nm	p2003

Scalings for vector object

Table 8- 2 Scalings for vector object

Variable	Scaling parameter	Default for quick commissioning
Reference speed	100 % = p2000	p2000 = Maximum speed (p1082)
Reference voltage	100 % = p2001	p2001 = 1000 V
Reference current	100 % = p2002	p2002 = Current limit (p0640)
Reference torque	100 % = p2003	p2003 = 2 x rated motor torque
Reference power	100 % = r2004	r2004 = (p2003 x p2000 x π) / 30
Reference frequency	100 % = p2000/60	
Reference modulation depth	100 % = Maximum output voltage without overload	
Reference flux	100 % = Rated motor flux	
Reference temperature	100% = 100°C	

Signals for the analog outputs: object A_INF

Table 8- 3 List of signals for the analog outputs - object A_INF

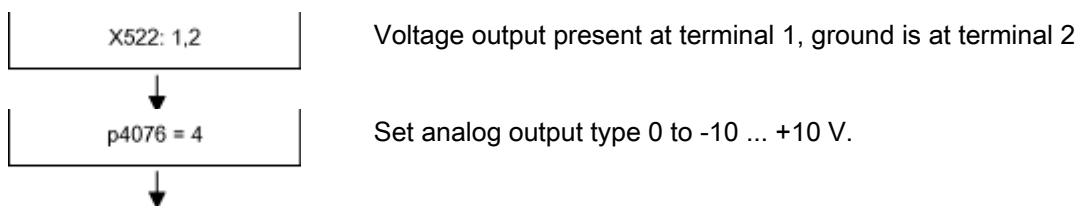
Signal	Parameter	Unit	Scaling (100 %=...) See table below
Output current	r0068	Aeff	p2002
DC link voltage	r0070	V	p2001
Modulation depth	r0074	%	Reference modulation depth
Torque-generating current setpoint	r0077	A	p2002
Torque-generating actual current	r0078	A	p2002
Output power	r0082	kW	r2004

Scalings for object A_INF

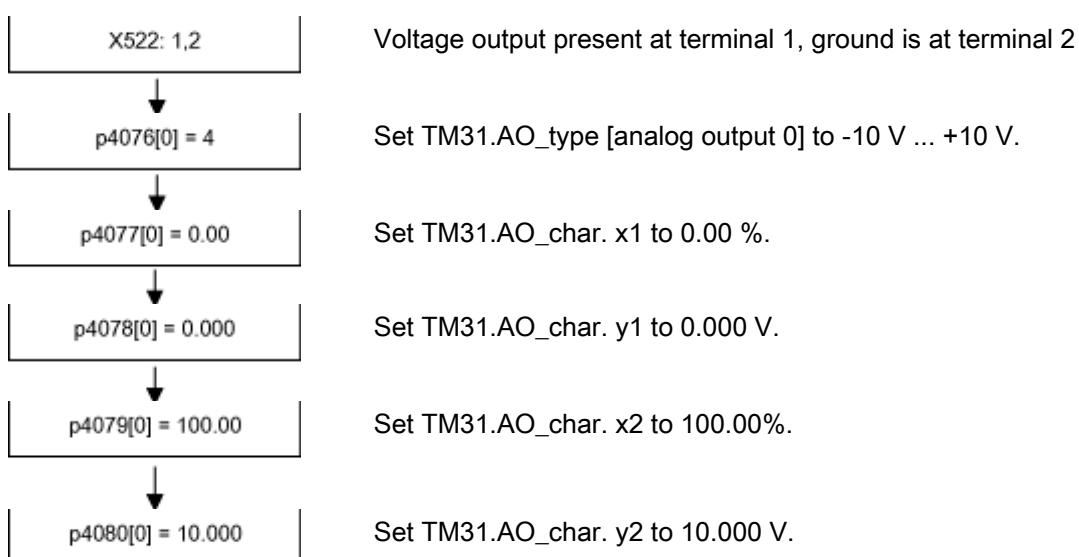
Table 8- 4 Scalings for object A_INF

Variable	Scaling parameter	Default for quick commissioning
Reference frequency	100 % = p2000	p2000 = p0211
Reference voltage	100 % = p2001	p2001 = r0206/r0207
Reference current	100 % = p2002	p2002 = r0207
Reference power	100 % = r2004	r2004 = r0206
Reference modulation depth	100 % = Maximum output voltage without overload	
Reference temperature	100% = 100°C	

Example: changing analog output 0 from current to voltage output -10 V ... +10 V



Example: changing analog output 0 from current to voltage output -10 V ... +10 V and setting the characteristic



8.3 Digital outputs

Description

Four bi-directional digital outputs (terminal X541) and two relay outputs (terminal X542) are available. These outputs are, for the most part, freely parameterizable.

Signal flow diagram

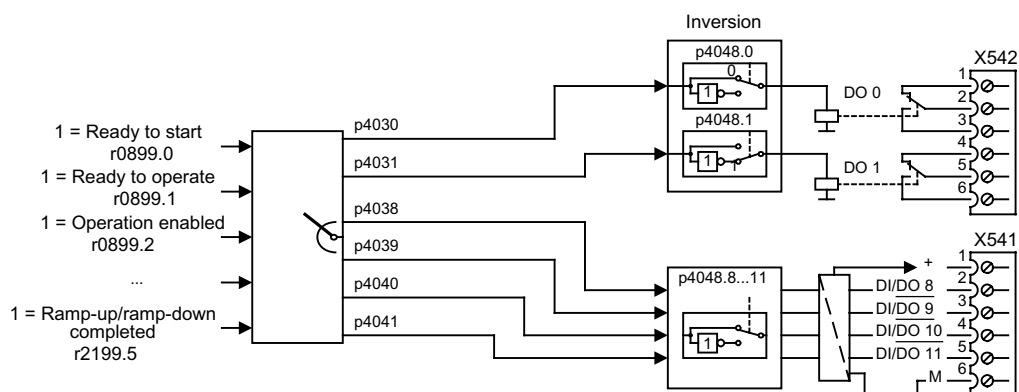


Figure 8-2 Signal flow diagram: Digital outputs

Factory settings

Table 8- 5 Factory settings for digital outputs

Digital output	Terminal	Factory setting
DO0	X542: 2,3	"Enable pulses"
DO1	X542: 5,6	"No fault"
DI/DO8	X541: 2	"Ready to start"
DI/DO9	X541: 3	
DI/DO10	X541:4	
DI/DO11	X541: 5	

Selection of possible connections for the digital outputs

Table 8- 6 Selection of possible connections for the digital outputs

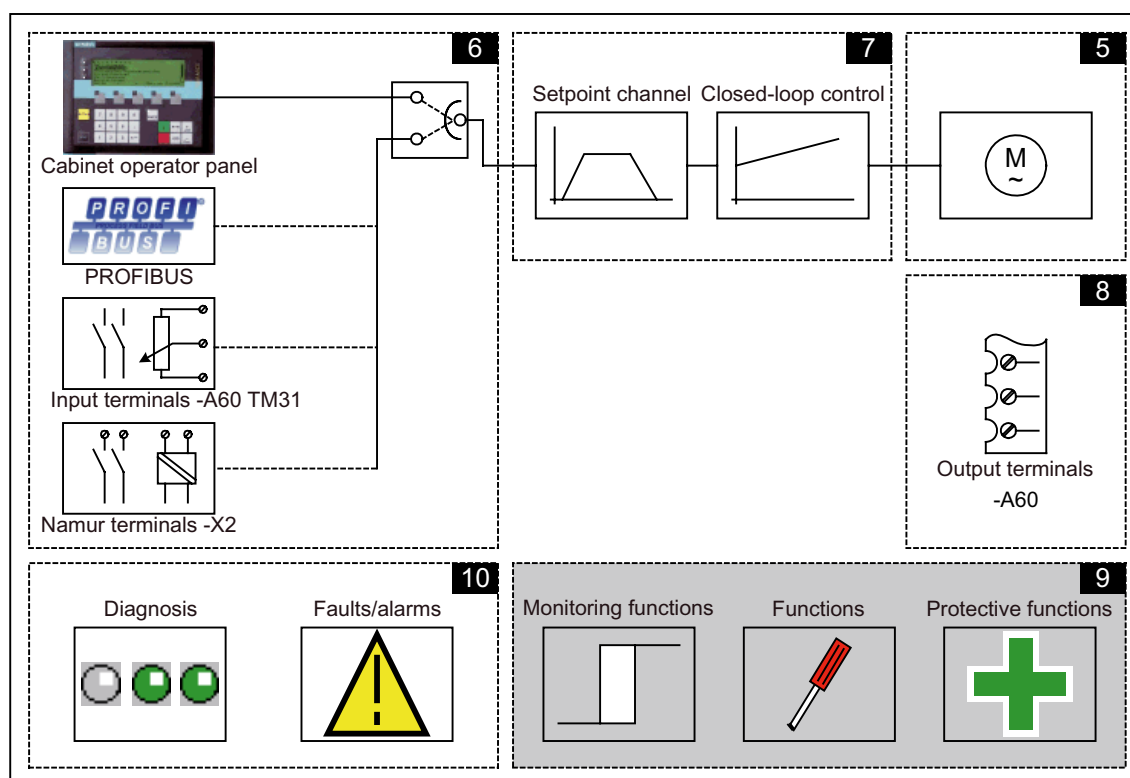
Signal	Bit in status word 1	Parameter
1 = Ready to start	0	r0889.0
1 = Ready to operate (DC link loaded, pulses blocked)	1	r0889.1
1 = Operation enabled (drive follows n_set)	2	r0889.2
1 = Fault present	3	r2139.3
0 = Coast to stop active (OFF2)	4	r0889.4
0 = Fast stop active (OFF3)	5	r0889.5
1 = Power-on disable	6	r0889.6
1 = Alarm present	7	r2139.7
1 = Speed setpoint/actual deviation in the tolerance bandwidth (p2163, p2166)	8	r2197.7
1 = Control required to PLC	9	r0899.9
1 = f or n comparison value reached or exceeded (p2141, p2142)	10	r2199.1
1 = I, M, or P limit reached (p0640, p1520, p1521)	11	r1407.7
Reserved	12	
0 = Alarm motor overtemperature (A7910)	13	r2129.14
Reserved	14	
0 = Alarm thermal overload in power unit (A5000)	15	r2129.15
1 = Pulses enabled (inverter is clocking, drive is carrying current)		r0899.11
1 = n_act ≤ p2155		r2197.1
1 = n_act > p2155		r2197.2
1 = Ramp-up/ramp-down completed		r2199.5
1 = n_act < p2161 (preferably as n_min or n=0 message)		r2199.0
1 = Torque setpoint < p2174		r2198.10
1 = LOCAL mode active (control via operator panel or control panel)		r0807.0
0 = Motor blocked		r2198.6

Functions, monitoring, and protective functions

9.1 Chapter content

This chapter provides information on:

- Drive functions:
Motor identification, Vdc control, automatic restart, flying restart, motor changeover, friction characteristic, increase in the output frequency, runtime, simulation operation, direction reversal, unit changeover
- Active Infeed functions:
line and DC link identification, harmonics controller
- Extended functions:
Technology controller, bypass function, extended brake control, extended monitoring functions, position control, basic positioner
- Monitoring and protective functions:
Power unit protection, thermal monitoring functions and overload responses, blocking protection, stall protection, thermal motor protection.



Function diagrams

To supplement these operating instructions, the documentation folder contains simplified function diagrams describing the operating principle.

The diagrams are arranged in accordance with the chapters in the operating instructions. The page numbers (9xx) describe the functionality in the following chapter.

At certain points in this chapter, reference is made to function diagrams with a 4-digit number. These can be found on the documentation CD in the "SINAMICS List Manual", which provides experienced users with detailed descriptions of all the functions.

9.2 Active Infeed functions

9.2.1 Line and DC link identification

Description

Automatic parameter identification is used to determine all the line and DC link parameters, thereby enabling the controller setting for the Line Module to be optimized.

Note

If the line environment or DC link components are changed, automatic identification should be repeated with p3410 = 4 (e.g. once the system has been installed or the drive line-up extended).

The rated current flows during line identification, which can result in a supply-side voltage dip.

Identification methods

- 0: Identification (Id) off
- 1: Activate identification (Id)
- 2: Set controller setting
- 3: Identify and save controller setting
- 4: Identify and save controller setting with L adaptation

Note

You are advised to use this identification method.

- 5: Reset, save controller setting with L adaptation

For p3410 = 1, 3, 4, 5, alarm A06400 is output to indicate that the specified identification will take place after the next pulse enable.

p3410 is automatically set to 0 after an identification run has been fully completed.

Parameter

- p3410 Infeed identification method
- r3411 Infeed identified inductance
- r3412 Infeed DC-link capacitance identified
- p3421 Infeed inductance
- p3422 Infeed DC link capacitance
- p3620 Infeed current controller adaptation lower application threshold
- p3622 Infeed current controller adaptation reduction factor

9.2.2 Harmonics controller

Description

Harmonics in the supply voltage cause harmonics in the line currents. Current harmonics can be reduced by activating the harmonics controller.

Example: setting the harmonics controller

The 5th and 7th harmonic are to be compensated:

Table 9- 1 Sample parameters for the harmonics controller

Index	p3624 Infeed harmonics controller order	p3625 scaling
[0]	5	100 %
[1]	7	100 %

0% scaling means that the harmonics controller has been deactivated.

100 % scaling means that the harmonics controller has been activated with standard gain.

The phase currents in parameter p0069[0...2] (U, V, W) can be verified using the STARTER trace function.

Parameters

- r0069[0...6] Phase current, actual value
- p3624[0...1] Infeed harmonics controller order
- p3625[0...1] Infeed harmonics controller scaling

9.2.3 Variable power factor (reactive power compensation)

Description

Changing the reactive current allows the power factor of the cabinet unit to be set as capacitive or inductive.

The reactive current can be changed by specifying a parameterizable supplementary setpoint for the reactive current by means of higher-level cos control.

Function diagram

FD 8946 Power pre-control/current controller/gating unit

Parameters

- p3610 Infeed reactive current fixed setpoint
- p3611 Infeed reactive current supplementary setpoint

9.2.4 Settings for the infeed (Active Infeed) under difficult line conditions

Description

The following setting examples are taken from commissioning procedures and are not generally valid! The required control characteristics must be checked again after the settings have been made.

Example 1: Infeed to a generator functioning as an energizing supply

Infeed error during line identification, power failure (F6200, A6205)

Following procedure:

1. Exclude other sources of fault: e.g. actual power failure, wiring fault, correct supply data setting (p0210, p0211)
2. Reset the infeed parameters, re-enter the supply data
3. p0281 Line supply overvoltage, warning threshold = 150%
p0283 Line supply undervoltage, shutdown (trip) threshold = 50%
p0284 Line supply frequency exceeded, alarm threshold = 125%
p0285 Min. line supply frequency not maintained, alarm threshold = 75%
→ Start supply ID (p3410 = 5)
4. If 3. is not successful, then in addition:
Reduction in excitation current p3415[0] = 4%, p3415[1] = 8%
→ Start supply ID (p3410 = 5)
5. If 4. is not successful, then in addition (for FW ≤ 2.4 only):
Gradual increase in value of infeed inductance between supply and filter p0225 (initial value: 0.3/0.5/0.7 x p0223),
Limit p3421 to (2 x p0233)
→ Start each supply ID
6. If 5. is not successful, then in addition:
p3463 Infeed, line angle change, phase failure detection = 20° ... 40°
p3458[1] Infeed PLL smoothing time = 8 ms .. 25 ms
p3472[1] Reduce infeed supply voltage smoothing time to 20 ms ... 100 ms
(both parameters only visible at service access level)
→ Start supply ID
7. If 6. is not successful, then in addition:
Change controller gain p3560 = 10% .. 300 % (Vdc controller)

Note

The service parameters can only be accessed by authorized Siemens personnel.

If a particular setting is not possible or special application-specific supplementary conditions are present, individual steps can also be omitted.

8. If no return feed possible in regenerative operation: p3533 = 1 (inhibit regenerative operation)

Example 2: Faults during operation when loading the infeed, operating on a "normal" supply.

Power failure (F6200, A6205), DC link overvoltage (F30002)

Following procedure:

1. Exclude other sources of fault: e.g. actual power failure, wiring fault, correct supply data setting (p0210, p0211)
2. If 1. is not successful, then in addition (for $FW \leq 2.4$ only):
Gradual increase in value of infeed inductance between supply and filter p0225 (initial value: 0.3/0.5/0.7 x p0223),
Limit p3421 to 2 x p0233
→ Start each supply ID (p3410 = 5)
3. If 2. is not successful, then in addition:
p3463 Infeed, line angle change, phase failure detection = 15° ... 30°
p3458[1] Infeed PLL smoothing time = 8 ms .. 25 ms
(both parameters only visible at service access level)
→ Run load test
4. If 3. is not successful, then in addition:
Change controller gain p3560 = 10% .. 300%
and, if necessary, integral action time p3562 = 50% (Vdc controller)
→ Run load test
5. If 4. is not successful, then in addition:
Change voltage setpoint p3510, increase or decrease depending on fault pattern and application
→ Run load test
6. If 5. is not successful, then in addition:
p3530 Set motorized infeed current limit to active infeed rated current (r0207).
Set p3531 Regenerating infeed current limit to the negative active infeed rated current value (r0207)
→ Run load test

Note

The service parameters can only be accessed by authorized Siemens personnel.

If a particular setting is not possible or special application-specific supplementary conditions are present, individual steps can also be omitted.

9.3 Drive functions

9.3.1 Motor identification and automatic speed controller optimization

Description

Two motor identification options, which are based on each other, are available:

- Standstill measurement with p1910 (motor identification)
- Rotating measurement with p1960 (speed controller optimization)

These can be selected more easily via p1900. p1900 = 2 selects the standstill measurement (motor not rotating). p1900 = 1 also activates the rotating measurement; p1900 = 1 sets p1910 = 1 and p1960 in accordance with the current control type (p1300).

Parameter p1960 is set depending on p1300:

- p1960 = 1, if p1300 = 20 or 22 (encoderless control)
- p1960 = 2, if p1300 = 21 or 23 (control with encoder)

The measurements parameterized using p1900 are started in the following sequence after the corresponding drive has been enabled:

- Standstill (static) measurement - after the measurement has been completed, the pulses are inhibited and parameter p1910 is reset to 0.
- Encoder adjustment - after the measurement has been completed, the pulses are inhibited and parameter p1990 is reset to 0.
- Rotating measurement - after the measurement has been completed, the pulses are inhibited and parameter p1960 is reset to 0.
- After all of the measurements activated using p1900 have been successfully completed, p1900 itself is set to 0.

Note

To set the new controller setting permanently, the data must be saved with p0977 or p0971 on the non-volatile CompactFlash card.

 DANGER

During motor identification, the drive might set the motor in motion.

The EMERGENCY STOP functions must be fully operational during commissioning. To protect the machines and personnel, the relevant safety regulations must be observed.

9.3.1.1 Standstill measurement

Description

Motor identification with p1910 is used for determining the motor parameters at standstill (see also p1960: speed controller optimization):

- Equivalent circuit diagram data p1910 = 1
- Magnetization characteristic p1910 = 3

For control engineering reasons, you are strongly advised to carry out motor identification because the equivalent circuit diagram data, motor cable resistance, IGBT on-state voltage, and compensation for the IGBT lockout time can only be estimated if the data on the type plate is used. For this reason, the stator resistance for the stability of sensorless vector control or for the voltage boost with the V/f characteristic is very important.

Motor identification is essential if long supply cables or third-party motors are used. When motor data identification is started for the first time, the following data is determined with p1910 = 1 on the basis of the data on the type plate (rated data):

- Equivalent circuit diagram data
- Total resistance of:
 - Power cable resistance (R_{cable}) and
 - Stator resistance (R_S)
- IGBT on-state voltage/compensation for the IGBT lockout time

Since the type plate data provides the initialization values for identification, you must ensure that it is entered correctly and consistently (taking into account the connection type (star/delta)) so that the above data can be determined.

If the resistance of the motor supply cable is known, you are advised to enter this value before the standstill measurement (p0352) so that it can be subtracted from the total measured resistance when the stator resistance (p0350) is calculated.

Entering the cable resistance improves the accuracy of thermal resistance adaptation, particularly when long supply cables are used. This governs behavior at low speeds, particularly during encoderless vector control.

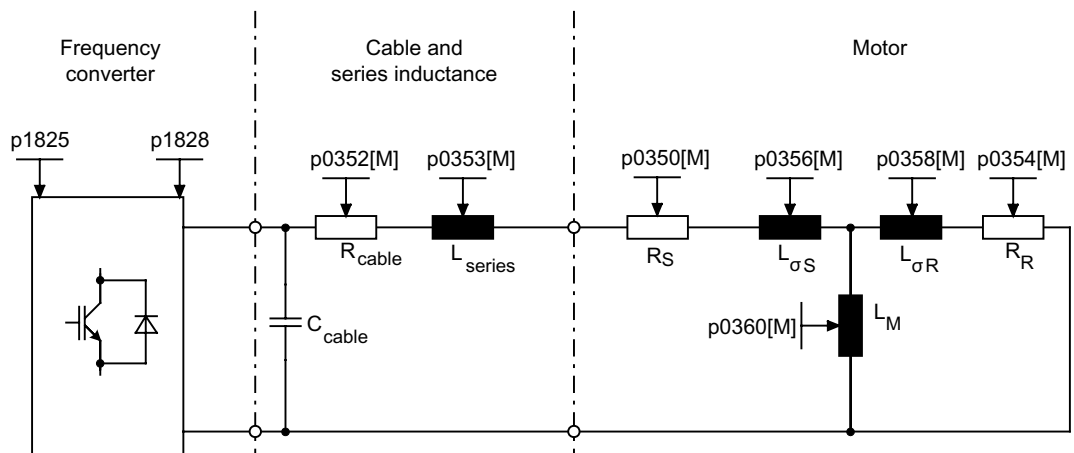


Figure 9-1 Equivalent circuit diagram for induction motor and cable

9.3 Drive functions

If an output filter (see p0230) or series inductance (p0353) is used, its data must also be entered before the standstill measurement is carried out.

The inductance value is then subtracted from the total measured value of the leakage. With sine-wave filters, only the stator resistance, valve threshold voltage, and valve interlocking time are measured.

Note

Leakage values in excess of 35 to 40% of the rated motor impedance will restrict the dynamic response of speed and current control in the voltage limit range and in field-weakening operation.

Note

Standstill measurement must be carried out when the motor is cold. In p0625, enter the estimated ambient temperature of the motor during the measurement (with KTY sensor: set p0600, p0601 and read r0035). This is the reference point for the thermal motor model and thermal R_s/R_R adaptation.

In addition to the equivalent circuit diagram data, motor data identification (p1910 = 3) can be used for induction motors to determine the magnetization characteristic of the motor. Due to the higher accuracy, the magnetization characteristic should, if possible, be determined during rotating measurement (without encoder: p1960 = 1, 3; with encoder: p1960 = 2, 4). If the drive is operated in the field-weakening range, this characteristic should be determined for vector control in particular. The magnetization characteristic can be used to calculate the field-generating current in the field-weakening range more accurately, thereby increasing torque accuracy.

Note

In comparison with standstill measurement (p1910) for induction motors, rotating measurement (p1960) allows the rated magnetization current and saturation characteristic to be determined more accurately.

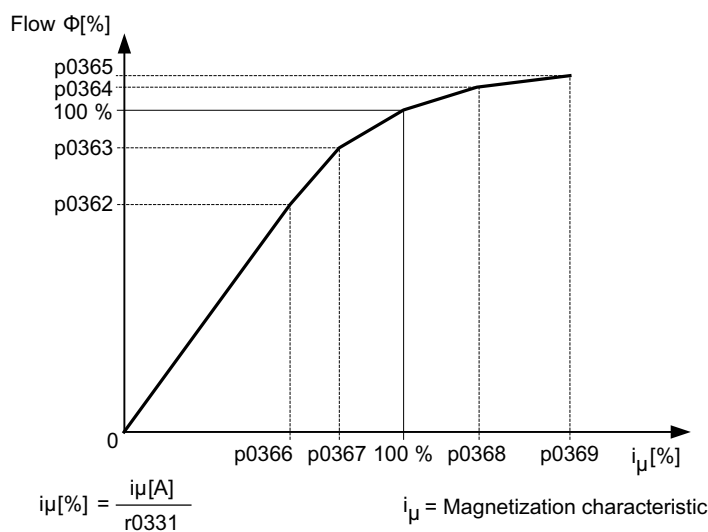


Figure 9-2 Magnetization characteristic

Carrying out motor identification

- Enter p1910 > 0. Alarm A07991 is displayed.
- Identification starts when the motor is switched on.
- p1910 resets itself to "0" (successful identification) or fault F07990 is output.
- r0047 displays the current status of the measurement.

Note

To set the new controller setting permanently, the data must be saved with p0977 or p0971 on the non-volatile CompactFlash card.



WARNING

During motor identification, the drive might set the motor in motion.

The EMERGENCY STOP functions must be fully operational during commissioning. To protect machines and personnel, the relevant safety regulations must be observed.

The following parameters are determined by means of motor identification:

- p1910 = 1 and induction motor:
p0350, p0354, p0356, p0358, p0360, p1825, p1828, p1829, p1830
- p1910 = 3 and induction motor:
p0362 ... p0366
- p1910 = 1 and permanent-magnet synchronous motor:
p0350, p0356, p0357, p1825, p1828, p1829, p1830

9.3.1.2 Rotating measurement and speed controller optimization

Description

"Rotating measurement" can be activated via p1960 or p1900 = 1.

The main difference between rotating measurement and standstill measurement is speed control optimization, with which the drive's moment of inertia is ascertained and speed controller is set. On induction motors, the saturation characteristic and rated magnetization current are also measured.

If rotating measurement is not to be carried out at the speed set in p1965, this parameter can be changed before the measurement is started. Higher speeds are recommended. The same applies to the speed in p1961, at which the saturation characteristic is determined and the encoder test is carried out.

The speed controller is set to the symmetrical optimum in accordance with dynamic factor p1967. p1967 must be set before the optimization run and only affects the calculation of the controller parameters.

If, during the measurement, it becomes clear that the the drive cannot operate in a stable manner with the specified dynamic factor or that the torque ripples are too great, the dynamic response is reduced automatically and the result displayed in r1968. The drive must

also be checked to ensure that it is stable across the entire range. The dynamic response might need to be reduced or Kp/Tn adaptation for the speed controller parameterized accordingly.

When commissioning induction machines, you are advised to proceed as follows:

- Before connecting the load, a complete "rotating measurement" (without encoder: p1960 = 1; with encoder: p1960 = 2) should be carried out. Since the induction machine is idling, you can expect highly accurate results for the saturation characteristic and the rated magnetization current.
- When the load is connected, speed controller optimization should be repeated because the total moment of inertia has changed. This is realized by selecting parameter p1960 (without encoder: p1960 = 3; with encoder: p1960 = 4).

When permanent-magnet synchronous motors are commissioned, the speed controller should be optimized (p1960 = 2/4) when the load is connected.

Carrying out the rotating measurement (p1960 = 1, 2)

The following measurements are carried out when the enable signals are set and a switch-on command is issued in accordance with the settings in p1959 and p1960.

- Encoder test
If a speed encoder is used, the direction of rotation and the pulse number are checked.
- Only for induction motors:
 - Measurement of the magnetization characteristic (p0362 to p0369)
 - Measurement of the magnetization current (p0320) and determination of the offset voltage of the converter for offset compensation
 - Measurement of the saturation of the leakage inductance and setting of the current controller adaptation (p0391...p0393)
This is automatically activated with 1LA1 and 1LA8 motors (p0300 = 11, 18) (see p1959.5).
- Speed controller optimization
 - p1470 and p1472, if p1960 = 1 (encoderless operation)
 - p1460 and p1462, if p1960 = 2 (operation with encoder)
 - Kp adaptation switch-off
- Acceleration pre-control setting (p1496)
- Setting for ratio between the total moment of inertia and that of the motor (p0342)

Note

To set the new controller setting permanently, the data must be saved with p0977 or p0971 to non-volatile memory on the CompactFlash card.

 **DANGER**

During speed controller optimization, the drive triggers movements in the motor that can reach the maximum motor speed.

The EMERGENCY OFF functions must be fully operational during commissioning. To protect machines and personnel, the relevant safety regulations must be observed.

Note

If speed controller optimization is carried out for operation with an encoder, the control mode will be changed over to encoderless speed control automatically, in order to be able to carry out the encoder test.

Parameter

- r0047 Status identification
- p1300 Open-loop/closed-loop control operating mode
- p1900 Motor data identification and rotating measurement
- p1959 Speed controller optimization configuration
- p1960 Speed controller optimization selection
- p1961 Saturation characteristic speed for calculation
- p1965 Speed controller optimization speed
- p1967 Speed controller optimization dynamic factor
- r1969 Speed controller optimization inertia identified
- r3925 Identification complete indicator
- r3927 MotId control word
- r3928 Rotating measurement configuration

9.3.2 Efficiency optimization

Description

The following can be achieved when optimizing efficiency using p1580:

- Lower motor losses in the partial load range
- Minimization of noise in the motor

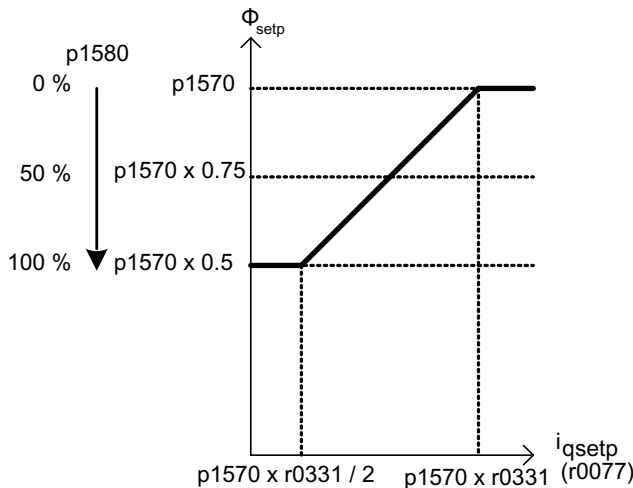


Figure 9-3 Efficiency optimization

It only makes sense to activate this function if the dynamic response requirements of the speed controller are low (e.g., pump and fan applications).

For p1580 = 100%, the flux in the motor under no-load operating conditions is reduced to half of the setpoint (reference flux) (p1570/2). As soon as load is connected to the drive, the setpoint (reference) flux increases linearly with the load and, reaching the setpoint set in p1570 at approx. r0077 = r0331 x p1570.

In the field-weakening range, the final value is reduced by the actual degree of field weakening. The smoothing time (p1582) should be set to approx. 100 to 200 ms. Flux differentiation (see also p1401.1) is automatically deactivated internally following magnetization.

Function diagram

- FP 6722 Field weakening characteristic, Id setpoint (ASM, p0300 = 1)
- FP 6723 Field weakening control, flux control for induction motor (p0300 = 1)

Parameters

- r0077 Current setpoints, torque-generating
- r0331 Motor magnetizing current/short-circuit current (actual)
- p1570 Flux setpoint
- p1580 Efficiency optimization

9.3.3 Fast magnetization for induction motors

Description

Fast magnetization for induction motors is used to reduce delay time during magnetization.

Features

- Rapid flux build-up by impressing a field-producing current at the current limit, which considerably reduces the magnetization time.
- If the "Flying restart" function is activated, the excitation build-up time set in p0346 is still used.

Commissioning

Parameter setting p1401.6 = 1 is necessary to activate fast magnetization.

Then magnetization is carried out with maximum current ($0.9 \times r0067$). When the flux setpoint is reached, the current is reduced via the smoothing p1616 (maximum $32 \times p0115[2]$).

If stator resistance identification is activated (see p0621), fast magnetization is deactivated internally and alarm A07416 displayed.

If there are conflicts in the configuration of parameter p1401, alarm A07416 is output and a fault detection procedure is used to display the particular conflict.

Function diagram

FP 6491	Flux control configuration
FP 6722	Field weakening characteristic, Id setpoint (ASM, p0300 = 1)
FP 6723	Field weakening controller, flux controller (ASM, p0300 = 1)

Parameter

- p0320 Motor rated magnetization current/short-circuit current
- p0346 Motor excitation build-up time
- p0621 Stator resistance identification after restart
- p0640 Current limit
- p1401 Flux control configuration
- p1570 Flux setpoint
- p1573 Flux threshold value magnetization
- p1590 Flux controller P gain
- p1616 Current setpoint smoothing time

9.3.4 Vdc control

Description

The "Vdc control" function can be activated using the appropriate measures if an overvoltage or undervoltage is present in the DC link.

- Overvoltage in the DC link (not relevant to S150).
- Undervoltage in the DC link
 - Typical cause:
Failure of the supply voltage or infeed for the DC link.
 - Remedy:
Specify a regenerative torque for the rotating drive to compensate the existing losses, thereby stabilizing the voltage in the DC link. This process is known as kinetic buffering.
Kinetic buffering is only possible as long as energy is generated by the movement of the drive.

Features

- Vdc control
 - This comprises Vdc_max control and Vdc_min control (kinetic buffering), which are independent of each other.
 - It includes a joint PI controller. The dynamic factor is used to set Vdc_min and Vdc_max control to a smoother or harder setting independently of each other.
- Vdc_min control (kinetic buffering)
 - With this function, the kinetic energy of the motor is used for buffering the DC link voltage in the event of a momentary power failure, thereby delaying the drive.
 - The motor is ramped up to its setpoint and continues to operate.
- Vdc_max control (not relevant to S150).

Description of Vdc_min control (kinetic buffering)

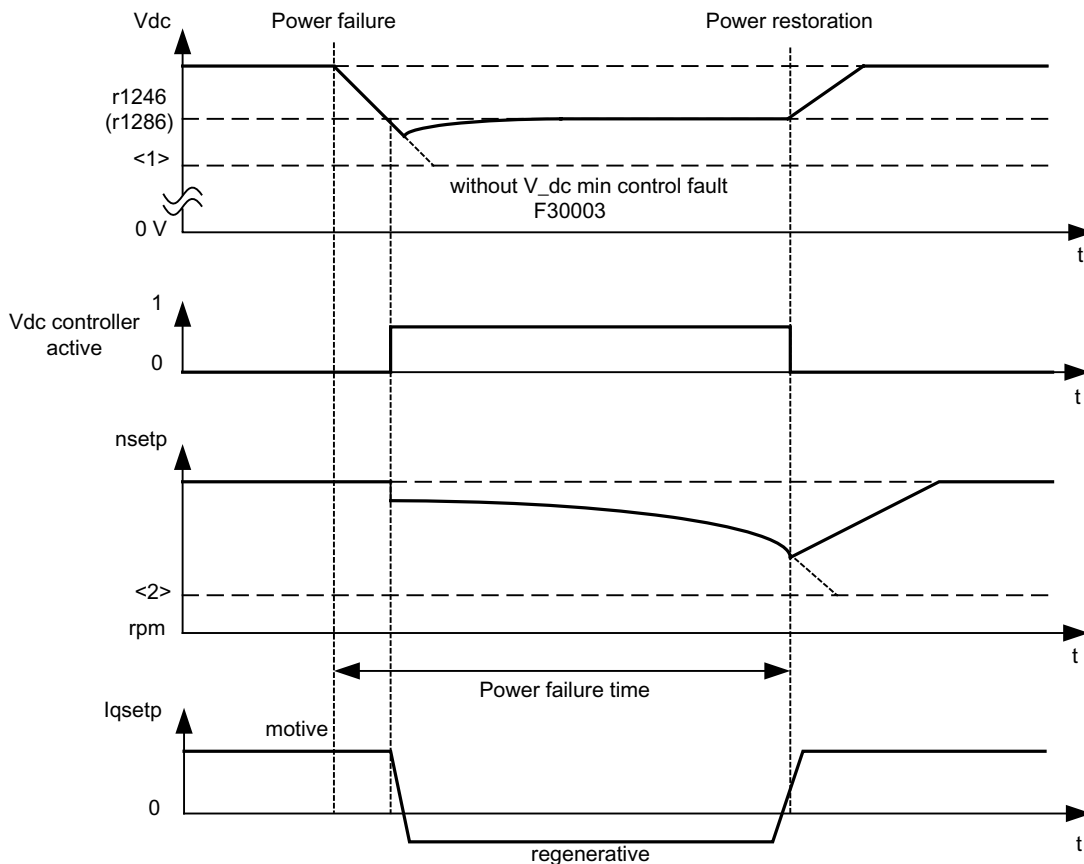


Figure 9-4 Switching Vdc_min control on/off (kinetic buffering)

Note

Kinetic buffering must only be activated in conjunction with an external power supply.

When Vdc_min control is enabled with p1240 = 2 (p1280), it is activated if the power fails when the Vdc_min switch-in level (r1246 (r1286)) is undershot. In general, the regenerative power (braking energy) of the drive machine generated when the motor speed is reduced is used to buffer the DC link voltage of the converter; in other words, when Vdc_min control is active, the motor speed no longer follows the main setpoint and can be reduced to zero. The SINAMICS system continues operating until the shutdown threshold of the DC link voltage is undershot (see "Switching Vdc_min control on/off" <1>).

Note

All parameter specifications in parentheses refer to V/f control.

- V/f control
The Vdc_min controller acts on the speed setpoint channel. When Vdc_min control is active, the drive setpoint speed is reduced so that the drive becomes regenerative.
- Speed control
The Vdc_min controller acts on the speed controller output and affects the torque-generating current setpoint. When Vdc_min control is active, the torque-generating current setpoint is reduced so that the drive becomes regenerative.

If the power fails, the DC link voltage decreases due to the lack of power from the supply system. When the DC link voltage threshold set via parameter p1245 (p1285) is reached, the Vdc_min controller is activated. Due to the PID properties of the controller, the motor speed is reduced to the extent that the regenerative drive energy maintains the DC link voltage at the level set in p1245 (p1285). The kinetic energy of the drive governs the dropout characteristic of the motor speed and, in turn, the buffering duration. In centrifugal mass drives (e.g. fans), buffering can last a few seconds. In drives with a low centrifugal mass (e.g. pumps), however, buffering can last just 100 – 200 ms. When the power is restored, the Vdc_min controller is deactivated and the drive is ramped up to its setpoint speed at the ramp-function generator ramp. As long as the Vdc_min controller is active, an alarm A7402 (drive: DC link voltage minimum controller active) will be issued.

If the drive can no longer generate any regenerative energy (because, for example, it is almost at a standstill), the DC link voltage continues to drop. If the minimum DC link voltage is undershot (see "Switching Vdc_min control on/off" <1>), the drive will shut down with fault F30003 (power unit: DC link undervoltage).

If a speed threshold set with parameter p1257 (p1297) for active Vdc_min control (see diagram "Switching Vdc_min control on/off" <2>) is undershot, the drive is shut down with F7405 (drive: kinetic buffering minimum speed not reached).

If a shutdown with undervoltage in the DC link (F30003) occurs without the drive coming to a standstill despite the fact that Vdc_min control is active, the controller may have to be optimized via dynamic factor p1247 (p1287). Increasing the dynamic factor in p1247 (p1287) causes the controller to intervene more quickly. The default setting for this parameter, however, should be sufficient for most applications.

Parameter p1256 = 1 (p1296) can be used to activate time monitoring for kinetic buffering. The monitoring time can be set in parameter p1255 (p1295). If buffering (i.e. the power failure) lasts longer than the time set here, the drive is switched off with fault F7406 (drive: kinetic buffering maximum time exceeded). The standard fault reaction for this fault is OFF3, which means that this function can be used for controlled drive deceleration in the event of a power failure. In this case, excess regenerative energy can only be dissipated via an additional braking resistor.

Function diagram

FD 6220 (FP 6320) Vdc_max controller and Vdc_min controller

Parameters

- p1240 (p1280) Vdc controller configuration
- p1245 (p1285) Vdc_min controller switch-in level
- p1247 (p1287) Vdc_min controller dynamic factor
- p1250 (p1290) Vdc controller proportional gain
- p1251 (p1291) Vdc controller integral action time
- p1252 (p1292) Vdc controller derivative-action time
- (p1293) Vdc_min controller output limit (V/f control)
- p1255 (p1295) Vdc_min controller time threshold
- p1256 (p1296) Vdc_min controller response
- p1257 (p1297) Vdc_min controller speed threshold
- r1258 (r1298) Vdc controller output

9.3.5 Automatic restart function

Description

The automatic restart function automatically restarts the cabinet unit after an undervoltage or a power failure. The alarms present are acknowledged and the drive is restarted automatically.

The drive can be restarted using:

- The standard procedure starting from standstill, or
- The flying restart function.
For drives with low moments of inertia and load torques facilitating the stopping of the drive within a matter of seconds (e.g., pump drives with water gauges), starting from standstill is recommended.

Note

The flying restart function can also be activated for drives with large moments of inertia (such as fan drives). This enables you to switch to the motor that is still rotating.

 WARNING
--

If p1210 is set to values >1, the motor can be restarted automatically without the need to issue the ON command.

In the event of prolonged power failures and when the automatic restart function is activated (p1210 > 1), the drive may have been at a standstill for a long time and mistakenly considered to have been switched off.

For this reason, entering the area around the drive when it is in this condition can cause death, serious injury, or considerable material damage.

Automatic restart mode

Table 9- 2 Automatic restart mode

p1210	Mode	Meaning
0	Disables automatic restart	Automatic restart inactive
1	Acknowledges all faults without restarting	If p1210 = 1, pending faults will be acknowledged automatically once their cause has been rectified. If further faults occur after faults have been acknowledged, these will also be acknowledged automatically. A minimum time of p1212 + 1 s must expire between successful fault acknowledgement and a fault re-occurring if the signal ON/OFF1 (control word 1, bit 0) is at a HIGH signal level. If the ON/OFF1 signal is set to LOW, the time between when a fault is acknowledged and another one occurs must be at least 1 s. If p1210 = 1, fault F07320 will not be generated if the acknowledge attempt fails (e.g., because the faults occurred too frequently).
4	Automatic restart after line supply failure, no additional startup attempts	If p1210 = 4, an automatic restart will only be performed if in addition fault F30003 occurs on the Motor Module or there is a high signal at binector input p1208[1], or in the case of an infeed drive object (A_Infeed), F06200 is pending. If additional faults are pending, then these faults will also be acknowledged; if this is successful, the startup attempt will be resumed. The failure of the CU's 24 V power supply will be interpreted as a line supply failure.
6	Restart after any fault with additional startup attempts	If p1210 = 6, an automatic restart will be performed after any fault or at p1208[0] = 1. If the faults occur one after the other, then the number of startup attempts is defined using p1211. Monitoring over time can be set using p1213.

Startup attempts (p1211) and waiting time (p1212)

p1211 is used to specify the number of startup attempts. The number is decremented internally after each successful fault acknowledgement (line supply voltage must be restored or the infeed signals that it is ready). Fault F07320 is output when the number of parameterized startup attempts is reached.

If p1211 = x, x + 1 startup attempts will be made.

Note

A startup attempt starts immediately when the fault occurs.

The faults are acknowledged automatically at intervals of half the waiting time p1212.

Following successful acknowledgement and restoration of the voltage, the system is automatically powered up again.

The startup attempt has been completed successfully once the flying restart and magnetization of the motor (induction motor) has been completed (r0056.4 = 1) and one additional second has expired. The startup counter is not reset to the initial value p1211 until this point.

If additional faults occur between successful acknowledgement and the end of the startup attempt, then the startup counter, when it is acknowledged, is also decremented.

Monitoring time power restoration (p1213)

The monitoring time starts when the faults are detected. If the automatic acknowledgements are not successful, the monitoring time will continue. If the drive has not successfully restarted by the time the monitoring time expires (flying restart and motor magnetization must have been completed: r0056.4 = 1), fault F07320 is output. Monitoring is deactivated by setting p1213 = 0.

If p1213 is set to a value lower than the sum of p1212, the magnetization time r0346 and the additional delay time due to flying restart, then fault F07320 will be generated on every restart attempt. If, for p1210 = 1, the time in p1213 is set to a value lower than p1212, then fault F07320 will also be generated on every restart attempt. The monitoring time must be extended if the faults that occur cannot be immediately and successfully acknowledged.

Parameter

- p1210 Automatic restart mode
- p1211 Automatic restart, start attempts
- p1212 Automatic restart, delay time start attempts
- p1213 Automatic restart, monitoring line supply return

Settings

To prevent the motor from switching to phase opposition when the drive is being restarted, there is a delay while the motor demagnetizes ($t = 2.3 \times$ motor magnetization time constant). Once this time has elapsed, the inverter is enabled and the motor is supplied with power.

9.3.6 Flying restart

Description

The "Flying restart" function (enabled via p1200) allows the converter to switch to a motor that is still rotating. Switching on the converter without the flying restart function would not allow any flux to build up in the motor while it is rotating. Since the motor cannot generate any torque without flux, this can cause it to switch off due to overcurrent (F07801).

The flying restart function first determines the speed of the drive with which V/f or vector control is initialized so that the converter and motor frequency can be synchronized.

During the standard start-up procedure for the converter, the motor must be at a standstill. The converter then accelerates the motor to the setpoint speed. In many cases, however, the motor is not at a standstill.

Two different situations are possible here:

1. The drive rotates as a result of external influences, such as water (pump drives) or air (fan drives). In this case, the drive can also rotate against the direction of rotation.
2. The drive rotates as a result of a previous shutdown (e.g. OFF 2 or a power failure). The drive slowly coasts to a standstill as a result of the kinetic energy stored in the drive train (example: induced-draft fan with a high moment of inertia and a steeply descending load characteristic in the lower speed range).

In accordance with the setting chosen (p1200), the flying restart function is activated in the following situations:

- Once power has been restored and the automatic restart function is active
- After a shutdown with the OFF2 command (pulse inhibit) when the automatic restart function is active
- When the ON command is issued.

Note

The flying restart function must be used when the motor may still be running or is being driven by the load to prevent shutdowns due to overcurrent (F7801).

Note

If the value set for parameter p1203 (search speed factor) is higher, the search curve is flatter and, as a result, the search time is longer. A lower value has the opposite effect.

In motors with a low moment of inertia, the flying restart function can cause the drive to accelerate slightly.

In group drives, the flying restart function should not be activated due to the different coasting properties of the individual motors.

9.3.6.1 Flying restart without encoder

Description

Depending on parameter p1200, the flying restart function is started with the maximum search speed $n_{\text{search,max}}$ once the de-excitation time (p0347) has elapsed (see diagram "Flying restart").

$$n_{\text{Search,max}} = 1.25 \times n_{\text{max}} \text{ (p1082)}$$

The flying restart function behaves differently with V/f control and vector control:

- V/f characteristic (p1300 < 20):
The search speed yielded from parameter p1203 reduces the search frequency in accordance with the motor current. The parameterizable search current (p1202) is injected here. If the search frequency is similar to the rotor frequency, a current minimum occurs. Once the frequency has been found, the motor is magnetized. The output voltage during the magnetization time (p0346) is increased to the voltage value yielded from the V/f characteristic (see "Flying restart").
- Vector control without encoder:
The motor speed is determined using the speed adaptation control loop for the electric motor model. To begin with, the search current (p1202) is injected and then the controller is activated starting from the maximum search frequency. The dynamic response of the controller can be altered using the search speed factor (p1203). If the deviation of the speed adaptation controller is not too great, the motor continues to be magnetized for the duration parameterized in p0346.

Once the excitation build-up time (p0346) has elapsed, the ramp-function generator is set to the actual speed value and the motor ramped up to the current setpoint frequency.

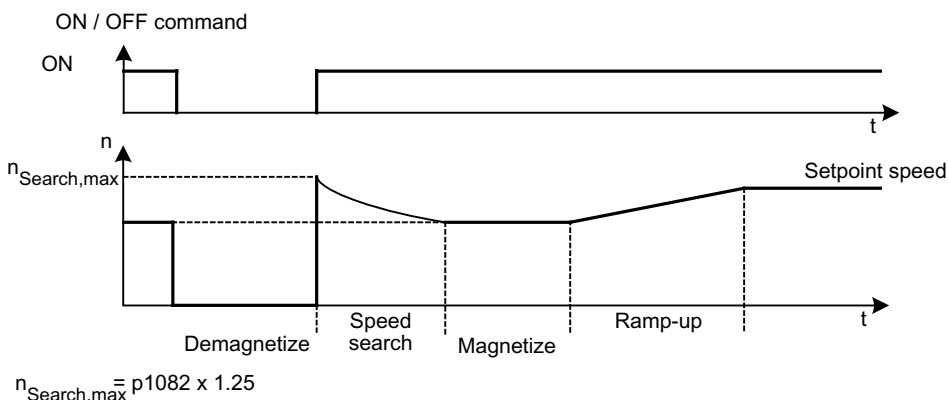



Figure 9-5 Flying restart

 WARNING
<p>When the flying restart (p1200) function is active, the drive may still be accelerated by the detection current despite the fact that it is at standstill and the setpoint is 0!</p> <p>For this reason, entering the area around the drive when it is in this condition can cause death, serious injury, or considerable material damage.</p>

9.3.6.2 Flying restart with encoder

Description

The flying restart function behaves differently with V/f control and vector control:

- V/f characteristic (p1300 < 20):
Flying restart without encoder (see "Flying restart without encoder")
- Vector control with encoder:
Since the speed is known from the start, the motor can be magnetized immediately at the appropriate frequency. The duration of magnetization is specified in p0346. Once the excitation build-up time has elapsed, the ramp-function generator is set to the actual speed value and the motor ramped up to the current setpoint speed.

 **WARNING**

When the flying restart (p1200) function is active, the drive may still be accelerated by the detection current despite the fact that it is at standstill and the setpoint is 0.

For this reason, entering the area around the drive when it is in this condition can cause death, serious injury, or considerable material damage.

9.3.6.3 Parameters

- p1200 Flying restart operating mode
 - 0: Flying restart inactive
 - 1: Flying restart is always active (start in the setpoint direction).
 - 2: Flying restart is active after: power-on, fault, OFF2 (start in the setpoint direction).
 - 3: Flying restart is active after: fault, OFF2. (start in the setpoint direction).
 - 4: Flying restart is always active (start only in the setpoint direction).
 - 5: Flying restart is active after: power-on, fault, OFF2 (start only in the setpoint direction).
 - 6: Flying restart is active after: fault, OFF2 (start only in the setpoint direction).
- p1202 Flying restart search current
- p1203 Flying restart search rate factor
- r1204 Flying restart, V/f control status
- r1205 Flying restart, vector control status

Note

For p1200 = 1, 2, 3, the following applies: Search in both directions, start only in the setpoint direction.

For p1200 = 4, 5, 6, the following applies: Search only in the setpoint direction.

9.3.7 Motor changeover/selection

9.3.7.1 Description

The motor data set changeover is, for example, used for:

- Changing over between different motors
- Motor data adaptation

Note

To switch to a rotating motor, the "flying restart" function must be activated.

9.3.7.2 Example of changing over between two motors

Prerequisites

- The drive has been commissioned for the first time.
- 2 motor data sets (MDS), p0130 = 2
- 2 drive data sets (DDS), p0180 = 2
- 2 digital outputs to control the auxiliary contactors
- 2 digital inputs to monitor the auxiliary contactors
- 1 digital input to select the data set
- 2 auxiliary contactors with auxiliary contacts (1 NO contact)
- 2 motor contactors with positively-driven auxiliary contacts (1 NC contact, 1NO contact)

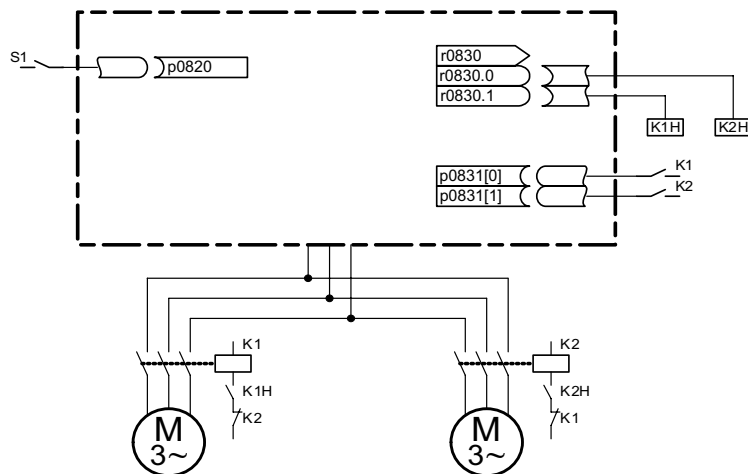


Figure 9-6 Example of motor changeover

Table 9- 3 Settings for motor changeover (example)

Parameters	Settings	Remark
p0130	2	Configure 2 MDS
p0180	2	Configure 2 DDS
p0186[0..1]	0, 1	The MDS are assigned to the DDS.
p0820	Digital input, DDS selection	The digital input to change over the motor is selected via the DDS. Binary coding is used (p0820 = bit 0 etc.).
p0821 to p0824	0	
p0826[0..1]	1, 2	Different numbers mean different thermal models.
p0827[0..1]	0, 1	The bits of p0830 are assigned to the MDS. If p0827[0] = 0, for example, bit p0830.0 is set via DDS0 when MDS0 is selected.
p0830.0 and p0830.1	Digital outputs, auxiliary contactors	The digital outputs for the auxiliary contactors are assigned to the bits.
p0831[0..1]	Digital inputs, auxiliary contacts	The digital inputs for the feedback signal of the motor contactors are assigned.
p0833.00 and .01	0, 0	The drive controls the contactors and pulse suppression.

Motor changeover sequence

1. Start condition:
For synchronous motors, the actual speed must be lower than the speed at the start of field weakening. This prevents the regenerative voltage from exceeding the terminal voltage.
2. Pulse suppression:
The pulses are suppressed following the selection of a new drive data set using p0820 to p0824.
3. Open motor contactor:
Motor contactor 1 is opened r0830 = 0 and the status bit "Motor changeover active" (r0835.0) is set.
4. Changeover drive data set:
The requested data set is activated (r0051 = data set currently effective, r0837 = requested data set).
5. Energize motor contactor:
After the feedback signal (motor contactor opened) from motor contactor 1, the appropriate bit of r0830 is set and motor contactor 2 is energized.
6. Enable pulses:
After the feedback signal (motor contactor closed) from motor contactor 2, the bit "motor data set changeover active" (r0835.0) is reset and the pulses are enabled. The motor has now been changed over.

9.3.7.3 Function diagram

FP 8565 Drive Data Set (DDS)
 FP 8575 Motor Data Sets (MDS)

9.3.7.4 Parameters

- r0051 Drive data set DDS effective
- p0130 Motor data sets (MDS) number
- p0180 Drive data set (DDS) number
- p0186 Motor data sets (MDS) number
- p0819[0...2] Copy drive data set DDS
- p0820 BI: Drive data set selection DDS, bit 0
- p0821 BI: Drive data set selection DDS, bit 1
- p0822 BI: Drive data set selection DDS, bit 2
- p0823 BI: Drive data set selection DDS, bit 3
- p0824 BI: Drive data set selection DDS, bit 4
- p0826 Motor changeover, motor number
- p0827 Motor changeover status word bit number
- p0828 Motor changeover, feedback signal
- r0830 Motor changeover, status
- p0831 Motor changeover, contactor feedback signal
- p0833 Data set changeover configuration

9.3.8 Friction characteristic curve

Description

The friction characteristic is used to compensate for the frictional torque of the motor and driven load. A friction characteristic allows the speed controller to be pre-controlled and improves the control response..

10 points along the characteristic are used for the friction characteristic. The coordinates of every point along the characteristic are defined by a speed parameter (p382x) and a torque parameter (p383x) (point 1 = p3820 and p3830).

Features

- There are 10 points along the characteristic to represent the friction characteristic.
- An automatic function supports the friction characteristic plot.
- A connector output (r3841) can be interconnected as friction torque (p1569).
- The friction characteristic can be activated and de-activated (p3842).


Commissioning

Speeds for making measurements as a function of the maximum speed p1082 are pre-assigned in p382x when commissioning the drive system for the first time. These can be appropriately changed corresponding to the actual requirements.

The automatic friction characteristic plot can be activated using p3845. The characteristic is then plotted the next time that it is enabled.

The following settings are possible:

- p3845 = 0 Friction characteristic plot de-activated
- p3845 = 1 Friction characteristic plot activated, all directions of rotation
The friction characteristic is plotted in both directions of rotation. The result of the positive and negative measurement is averaged and entered into p383x.
- p3845 = 2 Friction characteristic plot activated, positive direction of rotation
- p3845 = 3 Friction characteristic plot activated, negative direction of rotation

 **DANGER**

When the friction characteristic is plotted, the drive can cause the motor to move. As a result, the motor may reach maximum speed.

When commissioning the drive, the EMERGENCY STOP functions must function perfectly. To protect the machines and personnel, the relevant safety regulations must be observed.

Function diagram

FD 7010 Friction characteristic curve

Parameters

- p3820 Friction characteristic, value n0
- ...
- p3839 Friction characteristic, value M9
- r3840 Friction characteristic, status
- r3841 Friction characteristic, output
- p3842 Activate friction characteristic
- p3845 Activate friction characteristic plot

9.3.9 Increasing the output frequency

In applications that require higher output frequencies, the pulse frequency of the converter may have to be increased.

It may also be necessary to change the pulse frequency to prevent resonance from occurring.

Since increasing the pulse frequency also increases the switching losses, a derating factor for the output current must be taken into account when the drive is configured.

Once the pulse frequency has been increased, the new output currents are automatically included in the calculation for power unit protection.

Note

Use of a sine-wave filter (option L15) must be selected using p0230 = 3 when commissioning. This setting fixes the pulse frequency to 4 kHz or 2.5 kHz and it cannot be changed.

The following maximum output frequencies can be achieved with the default pulse frequencies listed below.

Table 9- 4 Maximum output frequency with default pulse frequency

Converter rating [kW]	Default pulse frequency [kHz]	Maximum output frequency [Hz]
Line voltage 380 – 480 V 3 AC		
110 – 250	2	160
315 – 800	1,25	100
Line voltage 500 – 690 V 3 AC		
75 – 1200	1,25	100

The pulse frequencies set in the factory are also the minimum frequencies.

The scanning times for the inputs and outputs of the customer terminal block TM31 are set in the factory to 4000 µs. This is also the minimum limit.

9.3.9.1 Increasing the pulse frequency

Description

The pulse frequency can be increased in a virtually continuously variable manner to between the value preassigned in the factory and the maximum pulse frequency which can be set.

Procedure

1. Parameter p0009 on the Control Unit must be set to 3 "Basic drive configuration".
2. Parameter p0112 "Sampling times default setting p0115" of the DO VECTOR must be set to 0 "Expert".
3. Use p0113 to enter any pulse frequency between 1 kHz and 2 kHz. If a higher pulse frequency is to be set (e.g. 2.2 kHz), this value must be divided by 2 or by 4 to obtain a result between 1 kHz and 2 kHz (e.g. 2.2 kHz divided by 2 is 1.1 kHz).
4. Not all pulse frequencies are accepted in parameter p0113; in such cases, the alarm "Impermissible value" is output.
5. If the frequency entered in parameter p0113 is not accepted, parameter r0114[0] recommends a different frequency that can deviate from the entered pulse frequency by several Hertz. This frequency should be entered in p0113.
6. After entering the frequency in p0113, parameter p0009 on the Control Unit must be set to 0 "Ready" again.
7. The Control Unit re-initializes. After booting, the pulse frequencies recommended in r0114[i] (i = 1, 2, ...) can be entered in parameter p1800 "Pulse frequency" of the DO VECTOR.

NOTICE
The pulse frequency entered in p1800 must correspond precisely to the value given in r0114[i]; otherwise, the entry will be rejected.

Maximum output frequencies achieved by increasing the pulse frequency

By multiplying the basis pulse frequency (with integers), the following output frequencies can be achieved (taking into account the derating factors):

Table 9- 5 Maximum output frequency achieved by increasing the pulse frequency

Pulse frequency [kHz]	Maximum output frequency [Hz]
1,25	100
2	160
2,5	200
4	300 ¹⁾
5	300 ¹⁾

¹⁾ The maximum output frequency is limited to 300 Hz due to the closed-loop control.

9.3.9.2 Parameters

- p0009 Device commissioning parameter filter
- p0112 Sampling times pre-setting p0115
- p0113 Selects the minimum pulse frequency
- p0115 Sampling times
- p1800 Pulse frequency

9.3.10 Runtime (operating hours counter)

Total system runtime

The entire system runtime is displayed in r2114 (Control Unit); it is made up of r2114[0] (milliseconds) and r2114[1] (days).

Index 0 indicates the system runtime in milliseconds; after reaching 86.400.000 ms (24 hours), the value is reset. Index 1 indicates the system runtime in days.

The value is saved when the system is switched off.

Once the drive unit has been switched on, the counter continues to run with the value that was saved the last time the drive was switched off.

Relative system runtime

The relative system runtime since the last POWER ON is displayed in p0969 (Control Unit). The value is indicated in milliseconds and the counter overflows after 49 days.

Actual motor operating hours

The motor operating hours counter p0650 (drive) resumes when the pulses are enabled. When the pulse enable is withdrawn, the counter is stopped and the value saved.

To store the value, you need a CU320 with order number 6SL3040-....-0AA1 and version C or higher.

The counter is deactivated with p0651 = 0.

If the maintenance interval set in p0651 is reached, alarm A01590 is triggered. Once the motor has been maintained, the maintenance interval must be reset.

Operating hours counter for the fan

The operating hours of the fan in the power unit are displayed in p0251 (drive).

The number of hours operated can only be reset to 0 in this parameter (e.g. after a fan has been replaced).

The service life of the fan is entered in p0252 (drive).

Alarm A30042 (service life of the fan reached or exceeded) is output when this figure is reached, and also 500 hours beforehand. Evaluation of the fault value in the alarm provides details of the cause of the alarm.

Monitoring is deactivated with p0252 = 0.

9.3.11 Simulation operation

Description

The simulation function is predominantly used to simulate the drive without a motor being connected and without a DC link voltage. In this case, it should be noted that the simulation mode can only be activated under an actual DC link voltage of 40 V. If the voltage lies above this threshold, the simulation mode is reset, and a fault message F07826 is issued.

Communications with a higher-level automation system can be tested using the simulation mode. If the drive is also to return actual values, note that it must be switched over to encoderless operation during simulation mode. This means that large parts of the SINAMICS software (e.g., software channel, sequence control, communications, technology function, etc.) can be tested in advance without requiring a motor.

Another application is to test the correct functioning of the Power Module. Especially for drive units with higher power ratings 75 kW (690 V) and 110 kW (400 V), after repairs, it is necessary to test the gating of the power semiconductors. This is done by injecting a low DC voltage as DC link voltage (e.g. 12 V). The drive unit is then powered-up and the pulses enabled. It must be possible to run through all of the pulse patterns of the gating unit software.

This means that the software must allow the pulses to be switched-in and various frequencies approached. If a speed encoder is not being used, then this is generally implemented using V/f control or sensorless closed-loop speed control.

Note

The following functions are de-activated in the simulation mode:

- Motor data identification
- Motor data identification, rotating without encoder
- Pole position identification

No flying restart is carried-out for V/f control and sensorless closed-loop vector control.

Commissioning

Simulation is activated using p1272 = 1; the following pre-requisites must be fulfilled:

- The drive unit must have been commissioned for the first time (default: Standard induction motors).
- The DC link voltage must lie below 40 V (observe the tolerance of the DC link voltage sensing).

Alarm A07825 (simulation mode activated) must be output during simulation operation.

Parameters

- p1272 Simulation operation

9.3.12 Direction reversal

Description

The direction of rotation of the motor can be reversed using direction reversal via p1821 without having to change the motor rotating field by interchanging two phases on the motor and inverting the encoder signals using p0410.

Reversal via p1821 can be detected from the motor direction of rotation. The speed setpoint and actual value, torque setpoint and actual value remain unchanged, as does the relative position change.

A pulse inhibit must be set prior to attempting reversal.

Reversing can be set differently for each drive data set.

Note

When changing over the drive data set to differently set reversing and with pulse approval, fault F7434 is issued.

Reversing can be observed by checking parameters r0069 (phase currents) and r0089 (phase voltage). The absolute position reference is lost on reversal.

Function diagram

FD 4704, 4715	Encoder evaluation
FD 6730, 6731	Current control

Parameters

- r0069 Phase currents actual value
- r0089 Phase voltage actual value
- p1820 Output phase direction reversal
- p1821 Direction reversal

9.3.13 Unit changeover

Description

Parameters and process variables for input and output can be switched to a suitable units system (SI units, US units or referenced variables (%)) with the help of the unit changeover function.

The following constraints apply to the unit changeover:

- Unit changeover is only possible for the "VECTOR" and "A_INF" drive object.
- Parameters of the rating plate of the drive converter or the motor rating plate can be changed over between SI/US units; however, a per unit representation is not possible.
- Once the changeover parameter has been changed, all parameters that are assigned to a unit group depending on this parameter are jointly changed over to the new unit.
- A separate parameter is available for selecting technological units (p0595) for the representation of technological variables in the technology controller.
- If a changeover is made to referenced variables and the reference variable is subsequently changed, the % value entered in a parameter will not change.

Example:

- A fixed speed of 80% corresponds, for a reference speed of 1500 rpm, to a value of 1200 rpm.
- If the reference speed is changed to 3000 rpm, the value of 80% is retained and is now 2400 rpm.

Restrictions

- When a unit changeover occurs, rounding to the decimal places is carried out. This can mean that the original value might change by up to one decimal place.
- If a referenced form is selected and the reference parameters (e.g. p2000) are changed retrospectively, the physical significance of some of the control parameters is also adjusted, which can affect the control behavior.
- Changing the reference variables (p2000 to p2007) in the STARTER in offline mode can cause parameter value limit violations, leading in turn to error messages when the values are loaded to the drive unit.

Changing over the units

The units can be changed over via the AOP30 and via STARTER.

- Unit changeover via AOP30 is always carried out immediately. Once the corresponding parameters have been changed, the values affected are displayed in the new selected unit.
- If STARTER is used, unit changeover can only take place in offline mode in the configuration screen of the corresponding drive object. The new units are not displayed until after the download ("Load project to target system") and subsequent upload ("Load project to PG") have been completed.

Unit groups

Each parameter that can be switched is assigned to a unit group which can be switched within certain limits depending on the group.

This assignment and the units groups for each parameter appear in the parameter list in the SINAMICS List Manual.

The unit groups can be individually switched using 4 parameters (p0100, p0349, p0505 and p0595).

Parameter

- p0010 Commissioning parameter filter
- p0100 IEC/NEMA mot stds
- p0349 Selection of units system, motor equivalent circuit diagram data
- p0505 Selection of units system
- p0595 Selection of technological unit
- p0596 Reference variable of technological unit
- p2000 Reference frequency/speed
- p2001 Reference voltage
- p2002 Reference current
- p2003 Reference torque
- p2004 Reference power
- p2005 Reference angle
- p2007 Reference acceleration

9.3.14 Derating behavior at increased pulse frequency

Description

To reduce motor noise or to increase output frequency, the pulse frequency can be increased relative to the factory setting.

The increase in the pulse frequency normally results in a reduction of the maximum output current (see "Technical data/current derating depending on the pulse frequency").

When commissioning the converter the behavior at overload is adjusted in such a manner that the pulse frequency is variably reduced so that the required power can be obtained.

Characteristics:

- The reaction to overload depends on the setting of parameter p0290:
 - p0290 = 0: Reduce output current or output frequency
 - p0290 = 1: No reduction, shutdown when overload threshold is reached
 - p0290 = 2: Reduce the output current or output and pulse frequency (not using I^2t).
 - p0290 = 3: Reduce the pulse frequency (not using I^2t)
- For p0290 = 2 at overload first reduce the pulse frequency (and consequently the output frequency) until it has dropped to rated pulse frequency, then reduce the output frequency if overload continues to persist.
The rated pulse frequency is half the inverse value of the current controller clock cycle: $0.5 \times 1/p0115[0]$.
- Reduction of the pulse frequency is executed in whole multiples based on the rated pulse frequency (5 kHz -> 2.5 kHz -> 1.25 kHz or 4 kHz -> 2 kHz).
- After entering the maximum speed in p1082 the system automatically calculates whether the pulse frequency is sufficient for the entered maximum speed, if necessary the pulse frequency is increased automatically to a value that is necessary for this.
At overload, then also for p0290 = 2 or 3, this new pulse frequency will no longer be underranged, the downstream reaction (reduce output voltage or switch off) will be triggered.

Exceptions:

- With an activated sinus filter (p0230 = 3, 4), this behavior is not permitted because the factory set pulse frequency (2.5 kHz or 4 kHz) should not be changed through this measure. Consequently in this case the selection possibility for the parameter p0290 is limited to "0" and "1".

Activation of the variable pulse frequency

At commissioning the parameter p 0290 is automatically set to the value "2". This activates pulse frequency reduction at overload.

Deactivation of the variable pulse frequency

By changing the parameter p0290 to "0" or "1" the variable pulse frequency is deactivated.

Function diagram

FP 8014 Signals and monitoring functions - thermal monitoring power unit

Parameter

- r0036 Power unit overload I2t
- r0037 CO: Power unit temperatures
- p0115 Sampling times for internal control loops
- p0230 Drive filter type, motor side
- p0290 Power unit overload response
- p1082 Maximum speed
- r2135.13 Fault thermal overload power unit
- r2135.15 Thermal overload in power unit alarm

9.4 Extended functions

9.4.1 Technology controller

Description

The "technology controller" function module allows simple control functions to be implemented, e.g.:

- Liquid level control
- Temperature control
- Dancer position control
- Pressure control
- Flow control
- Simple control without higher-level control
- Tension control

The technology controller features:

- Two scalable setpoints
- Scalable output signal
- Separate fixed values
- Separate motorized potentiometer
- The output limits can be activated and deactivated via the ramp-function generator.
- The D component can be switched to the system deviation or actual value channel.
- The motorized potentiometer of the technology controller is only active when the drive pulses are enabled.

The technology controller is designed as a PID controller, whereby the differentiator can be switched to the control deviation channel or the actual value channel (factory setting). The P, I, and D components can be set separately.

A value of 0 deactivates the corresponding component. Setpoints can be specified via two connector inputs. The setpoints can be scaled via parameters p2255 and p2256.

A ramp-function generator in the setpoint channel can be used to set the setpoint ramp-up/ramp-down time via parameters p2257 and p2258. The setpoint and actual value channel each have a smoothing element. The smoothing time can be set via parameters p2261 and p2265.

The setpoints can be specified via separate fixed setpoints (p2201 to p2215), the motorized potentiometer, or via the field bus (e.g. PROFIBUS).

Pre-control can be integrated via a connector input.

The output can be scaled via parameter p2295 and the control direction reversed. It can be limited via parameters p2291 and p2292 and interconnected as required via a connector output (r2294).

The actual value can be integrated, for example, via an analog input on the TM31.

If a PID controller has to be used for control reasons, the D component is switched to the setpoint/actual value difference (p2263 = 1) unlike in the factory setting. This is always necessary when the D component is to be effective, even if the reference variable changes. The D component can only be activated when $p2274 > 0$.

Note

With the entry "0" sec. as power up time or ramp-down time for the ramp function generator of the technology controller, the current values of the respective ramp function generator will be frozen.

Commissioning

The "technology controller" function module can be activated by running the commissioning Wizard. Parameter r0108.16 indicates whether the function module has been activated.

Function diagram

FD 7950	Technology controller – fixed values
FD 7954	Technology controller – motorized potentiometer
FD 7958	Technology controller – closed-loop controller

Example: liquid level control

The objective here is to maintain a constant level in the container.

This is carried out by means of a variable-speed pump in conjunction with a sensor for measuring the level.

The level is determined via an analog input (e.g. AI0 TM31) and sent to the technology controller. The level setpoint is defined in a fixed setpoint. The resulting controlled variable is used as the setpoint for the speed controller.

In this example, a Terminal Module (TM31) is used.

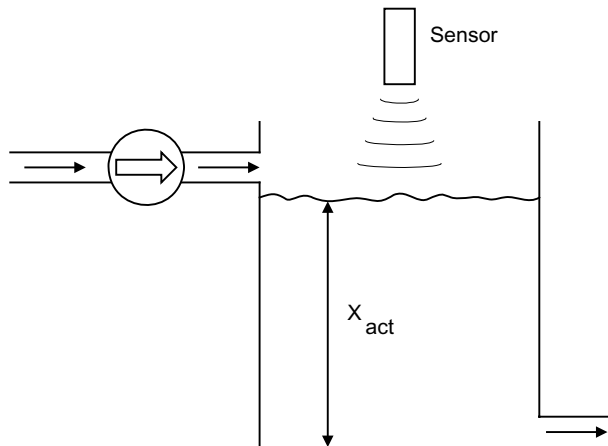


Figure 9-7 Level control: Application

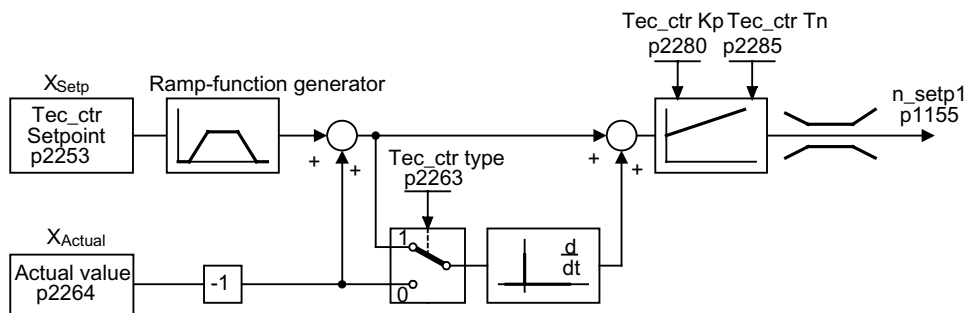


Figure 9-8 Level control: Controller structure

Key control parameters

- p1155 = r2294 n_setp1 downstream of RFG [FD 3080]
- p2253 = r2224 Technology controller setpoint effective via fixed setpoint [FD 7950]
- p2263 = 1 D component in fault signal [FD 7958]
- p2264 = r4055 Actual value signal X_{actual} via AI0 of TM31 [FP 9566]
- p2280 = Kp Calculate P gain by means of optimization
- p2285 = Tn Calculate integral time by means of optimization
- p2200 = 1 Technology controller enabled

9.4.2 Bypass function

The bypass function uses digital converter outputs to activate two contactors and uses digital inputs to evaluate the contactor's feedback (e.g. via TM31). This circuit allows the motor to be operated using the converter or directly on the supply line. The contactors are activated by the converter. The feedback signals for the contactor positions have to be returned to the converter.

The bypass circuit can be implemented in two ways:

- without synchronizing the motor to the supply and
- with synchronizing the motor to the supply.

The following applies to all bypass versions:

- The bypass switch is also shut down when one of the "OFF2" or "OFF3" control word signals is canceled.
- Exception:
If necessary, the bypass switch can be interlocked by a higher-level controller such that the converter can be shut down completely (i.e. including the controller electronics) while the motor is operated on the supply.
The protective interlocking must be implemented on the system side.
- When the converter is started up again after POWER OFF, the status of the bypass contactors is evaluated. After powering up, the converter can thereby change straight into "Ready to start and bypass" status. This is only possible if the bypass is activated via a control signal, the control signal (p1266) is still present once the system has been ramped up, and the automatic restart function (p1200 = 4) is active.
- Changing the converter into "Ready to start and bypass" status after powering up, is of a higher priority than switching back on automatically.
- Monitoring of the motor temperatures using temperature sensors is active while the converter is in one of two statuses "Ready to start and bypass" or "Ready to operate and bypass".
- The two motor contactors must be designed for switching under load.

Note

The examples contained in the following descriptions are only basic circuits designed to explain the basic function. The dimensions of specific circuit configurations (contactors, protective equipment) must be calculated for specific systems.

Prerequisites

The bypass function is only available for speed control without encoders (p1300 = 20) or V/f- control (p1300 = 0...19) and when using an asynchronous motor.

Establishing the bypass function

The bypass function is part of the "technology controller" function module that can be activated by running the commissioning Wizard. Parameter r0108.16 indicates whether the function module has been activated.

9.4.2.1 Bypass with synchronizer with degree of overlapping (p1260 = 1)

Description

When “Bypass with synchronizer with degree of overlapping (p1260 = 1)” is activated, the synchronized motor is transferred to the supply and retrieved again. During the changeover, both contactors K1 and K2 are closed at the same time for a period (phase lock synchronization).

A reactor is used to de-couple the drive converter from the line supply - the uk value for the reactor is 10 (± 2) %.

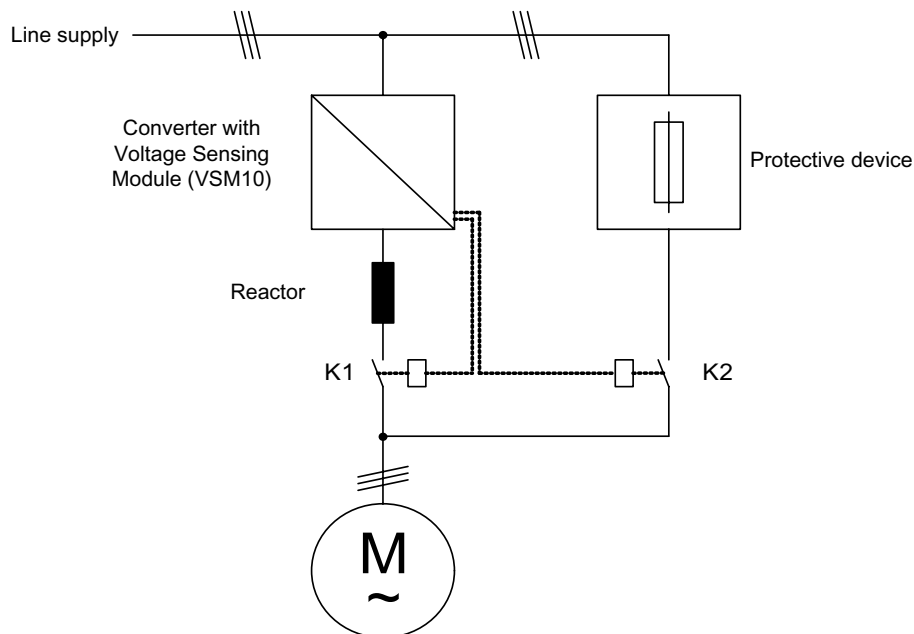


Figure 9-9 Typical circuit diagram for bypass with synchronizer with degree of overlapping

Activation

The function with synchronizer with degree of overlapping (p1260 = 1) function can only be activated using a control signal. It cannot be activated using a speed threshold or a fault.

Parameterization

Once the bypass with synchronizer with degree of overlapping (p1260 = 1) function has been activated, the following parameters must be set:

Table 9- 6 Parameter settings for bypass function with synchronizer with degree of overlapping

Parameter	Description
p1266 =	Control signal setting when p1267.0 = 1
p1267.0 = 1 p1267.1 = 0	Bypass function is initiated by the control signal
p1269[0] =	Signal source for contactor K1 feedback
p1269[1] =	Signal source for contactor K2 feedback
p3800 = 1	The internal voltages are used for synchronization.
p3802 = r1261.2	Synchronizer activation is triggered by the bypass function.

Transfer process

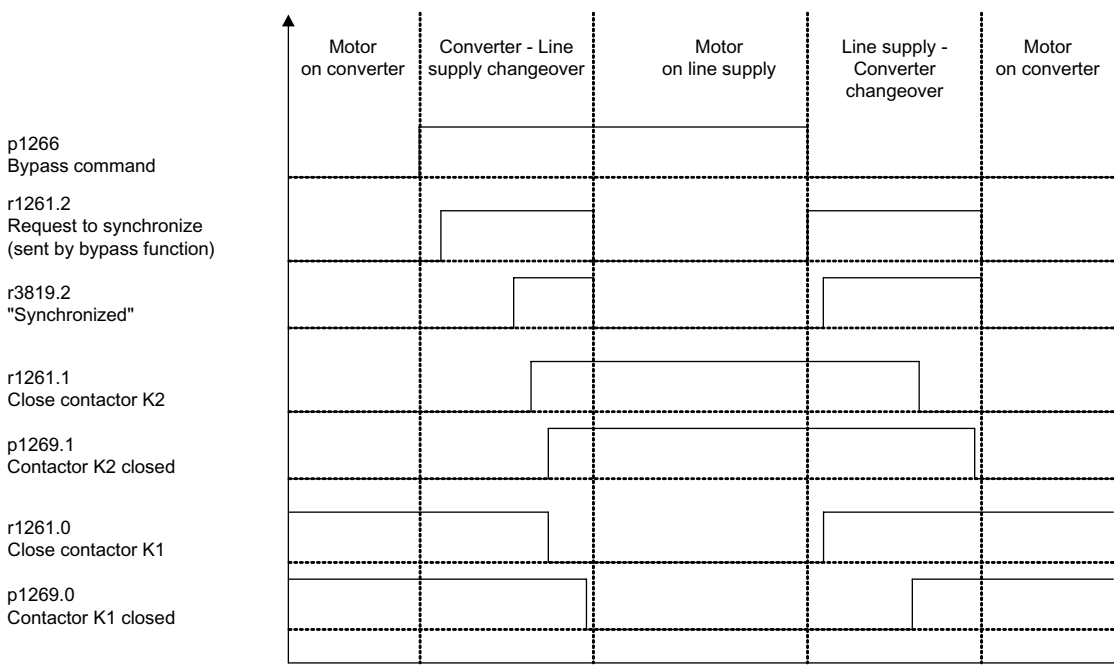


Figure 9-10 Signal diagram, bypass with synchronization with overlap

Transfer of motor to line supply

(contactors K1 and K2 are activated by the converter):

- The initial state is as follows: Contactor K1 is closed, contactor K2 is open and the motor is fed from the converter.
- The control bit "bypass command" (p1266) is set (e.g., by the higher-level automation).
- The bypass function sets the control word bit "synchronizing" (r1261.2).
- Since the bit is set while the converter is running, the "Transfer motor to line supply" synchronization process is started.
- Once motor synchronization to line frequency, line voltage and line phasing is complete, the synchronization algorithm reports this state (r3819.2).
- The bypass mechanism evaluates this signal and closes contactor K2 (r1261.1 = 1). The signal is evaluated internally - BICO wiring is not required.

- After contactor K2 has fed back the "closed" state ($r1269[1] = 1$), contactor K1 is opened and the converter inhibits the pulses. The converter is in "Ready for operation and bypass" state.
- If the On command is cancelled in this phase, the converter will change to "Ready to start and bypass" status. If the appropriate contactors are being used, the converter will be isolated from the line supply and the DC link discharged.

To transfer the motor back from the line supply, the sequence is simply reversed: At the start of the process, contactor K2 is closed and contactor K1 is open.

- The "Command bypass" control bit is canceled (e.g., by the higher-level automation).
- The bypass function sets the control word bit "synchronizing".
- The pulses are enabled. Since "synchronizing" is set before "pulse enable", the converter interprets this as a command to retrieve the motor from the line supply.
- Once converter synchronization to line frequency, line voltage and line phasing is complete, the synchronization algorithm reports this state.
- The bypass mechanism evaluates this signal and closes contactor K1. The signal is evaluated internally - BICO wiring is not required.
- Once contactor K1 has reported "closed" status, contactor K2 is opened and the motor returns to operation on the converter.

9.4.2.2 Bypass with synchronizer without degree of overlapping ($p1260 = 2$)

Description

When "Bypass with synchronizer without degree of overlapping ($p1260 = 2$)" is activated, contactor K2 (to be closed) is only closed when contactor K1 is opened (anticipatory type synchronization). Phasing of the motor voltage before synchronization must be set such that there is an "initial jump" upstream of the supply to which synchronization should be carried out. This done by setting the synchronization setpoint ($p3809$). A phase and frequency difference of around zero is produced when closing contactor K2 by braking the motor in the brief period in which both contactors are open.

In order for the function to run correctly, the moment of inertia must be sufficient.

Due to the expense of determining the synchronization setpoint ($p3809$), the decoupling restrictor is not needed.

The "flying restart" function must be activated ($p1200 = 1$).

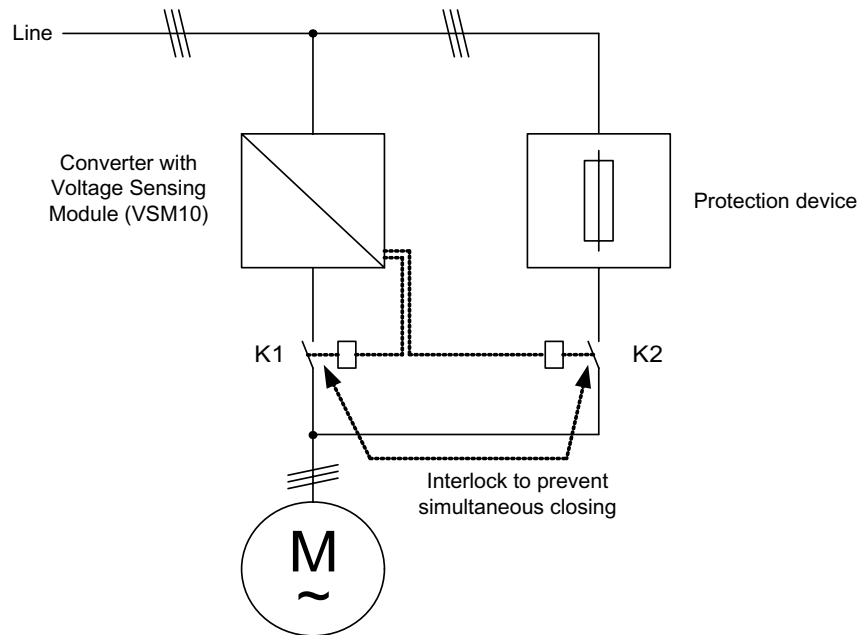


Figure 9-11 Example circuit for bypass with synchronizer without degree of overlapping

Activation

The bypass with synchronizer without degree of overlapping (p1260 = 2) function can only be activated using a control signal. It cannot be activated using a speed threshold or a fault.

Parameterization

Once the bypass with synchronizer without degree of overlapping (p1260 = 2) function has been activated, the following parameters must be set:

Table 9- 7 Parameter settings for bypass function with synchronizer without degree of overlapping

Parameters	Description
p1266 =	Control signal setting when p1267.0 = 1
p1267.0 = 1 p1267.1 = 0	Bypass function is initiated by the control signal
p1269[0] =	Signal source for contactor K1 feedback
p1269[1] =	Signal source for contactor K2 feedback
p3800 = 1	The internal voltages are used for synchronization.
p3802 = r1261.2	Synchronizer activation is triggered by the bypass function.
p1200 = 1	The "flying restart" function is always active.

9.4.2.3 Bypass without synchronizer (p1260 = 3)

Description

When the motor is transferred to the supply, contactor K1 is opened (following converter's pulse inhibit). The system then waits for the motor excitation time to elapse after which contactor K2 is closed and the motor is run directly on the supply.

If the motor is switched on in a non-synchronized manner, when activated an equalizing current flows and this must be taken into account when designing the protective equipment (see diagram "Circuit bypass without synchronization").

When the motor is being transferred from the supply by the converter, initially contactor K2 is opened and after the excitation time, contactor K1 is closed. The converter then captures the rotating motor and the motor is operated on the converter.

Contactor K2 must be designed for switching under load.

Contactors K1 and K2 must be interlocked against closing at the same time.

The "flying restart" function must be activated (p1200 = 1).

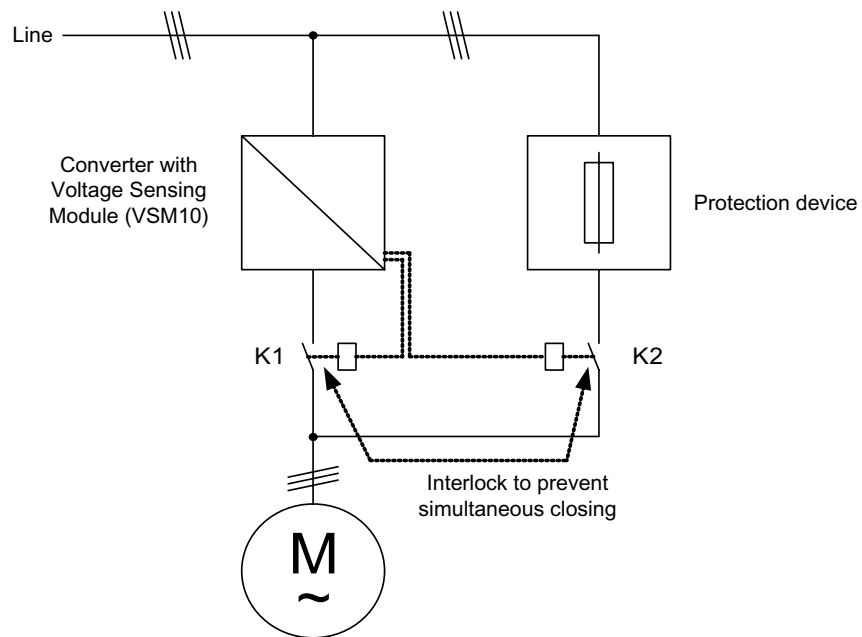


Figure 9-12 Example circuit for bypass without synchronization

Activation

The bypass with synchronizer (p1260 = 3) can be triggered by the following signals (p1267):

- Bypass by means of control signal (p1267.0 = 1):
The bypass can be activated by means of a digital signal (p1266) (e.g. from a higher-level automation system). If the digital signal is canceled, a changeover to converter operations is triggered once the debypass delay time (p1263) has expired.
- Bypass at speed threshold (p1267.1 = 1):
Once a certain speed is reached, the system switches to bypass (i.e. the converter is used as a start-up converter). The bypass cannot be connected until the speed setpoint is greater than the bypass speed threshold (p1265).
The system reverts to converter mode when the setpoint (on the input of the ramp-function generator, r1119) falls below the bypass speed threshold (p1265). The setpoint > comparison value condition prevents the bypass from being reactivated straight away if the actual speed is still above the bypass speed threshold (p1265) after switching back to converter operations.

The bypass time, debypass time, bypass speed variables and the command source for changing over are set using parameters.

Parameterization

Once the bypass without synchronizer (p1260 = 3) function has been activated, the following parameters must be set:

Table 9- 8 Parameter settings for bypass function with synchronizer without degree of overlapping

Parameter	Description
p1262 =	Bypass dead time setting
p1263 =	Debypass dead time setting
p1264 =	Bypass delay time setting
p1265 =	Speed threshold setting when p1267.1 = 1
p1266 =	Control signal setting when p1267.0 = 1
p1267.0 = p1267.1 =	Trigger signal setting for bypass function
p1269[1] =	Signal source for contactor K2 feedback
p3800 = 1	The internal voltages are used for synchronization.
p3802 = r1261.2	Synchronizer activation is triggered by the bypass function.
P1200 = 1	The "flying restart" function is always active.

9.4.2.4 Function diagram

FP 7020 Synchronization

9.4.2.5 Parameters

Bypass function

- p1200 Flying restart operating mode
- p1260 Bypass configuration
- r1261 CO/BO: Bypass control/status word
- p1262 Bypass dead time
- p1263 Debypass delay time
- p1264 Bypass delay time
- p1265 Bypass speed threshold
- p1266 BI: Bypass control command
- p1267 Bypass changeover source configuration
- p1268 BI: Bypass feedback signal synchronization completed
- p1269 BI: Bypass switch feedback signal
- p1274 BI: Bypass switch monitoring time

Synchronization

- p3800 Sync-supply-drive activation
- p3801 Sync-supply-drive drive object number
- p3802 BI: Sync-supply-drive enable
- r3803 CO/BO: Sync-supply-drive control word
- r3804 CO: Sync-supply-drive target frequency
- r3805 CO: Sync-supply-drive frequency difference
- p3806 Sync-supply-drive frequency difference threshold
- r3808 CO: Sync-supply-drive phase difference
- p3809 Sync-supply-drive phase setpoint
- p3811 Sync-supply-drive frequency limitation
- r3812 CO: Sync-supply-drive correction frequency
- p3813 Sync-supply-drive phase synchronism threshold
- r3814 CO: Sync-supply-drive voltage difference
- p3815 Sync-supply-drive voltage difference threshold
- r3819 CO/BO: Sync-supply-drive status word

9.4.3 Extended braking control

Description

The "extended braking control" function module allows complex braking control for motor holding brakes and operational brakes.

The brake is controlled as follows (the sequence reflects the priority):

- Via parameter p1215
- Via binector parameters p1219[0..3] and p0855
- Via zero speed detection
- Via a connector interconnection threshold value

Commissioning

The "extended braking control" function module can be activated by running the commissioning Wizard. Parameter r0108.14 indicates whether the function module has been activated.

Parameter p1215 must be set to "3" and the brake controlled via a digital output on customer terminal strip TM31.

Function diagram

FP 2704	Zero speed detection
FP 2707	Release/apply brake
FP 2711	Signal outputs

Example 1: Starting against applied brake

When the device is switched on, the setpoint is enabled immediately (if other enable signals are issued), even if the brake has not yet been released (p1152 = 1). The factory setting p1152 = r0899.15 must be separated here. The drive starts by generating a torque against the applied brake. The brake is not released until the motor torque or motor current (p1220) has exceeded braking threshold 1 (p1221).

This configuration is used, for example, when the drive is connected to a belt that is under tension (loop accumulator in the steel industry).

Example 2: Emergency brake

If emergency braking is required, electrical and mechanical braking is to take place simultaneously. This can be achieved if OFF3 is used as a tripping signal for emergency braking:

p1219[0] = r0898.2 (OFF3 to "apply brake immediately").

To prevent the converter working in opposition to the brake, the OFF3 ramp (p1135) should be set to 0 seconds. Regenerative energy may accumulate, and this must be either fed back into the supply system or converted into heat using a braking resistor.

This is often used, for example, in calendar stacks, cutting tools, running gears, and presses.

Example 3: Service brake on crane drives

For cranes with manual control, it is important that the drive responds immediately when the control lever is moved (master switch). To this end, the drive is powered up using the on command (p0840) (the pulses are enabled). Speed setpoint (p1142) and speed controller (p0856) are inhibited. The motor is magnetized. The magnetization time generally applicable for three-phase motors (1-2 seconds) is, therefore, eliminated.

Now, only the brake opening time will delay the motor starting to rotate following activation of the master switch. Movement of the master switch generates a "setpoint enable from the control" (bit interconnected with p1142, p1229.2, p1224.0). The speed controller is enabled immediately and the speed setpoint is enabled once the brake opening time (p1216) has elapsed. When the master switch is in the zero position, the speed setpoint is inhibited and the drive ramps down along the ramp-function generator's ramp-down ramp. The brake closes once the standstill limit (p1226) is undershot. Once the brake closing time (p1217) has elapsed, the speed controller is inhibited (the motor is no longer generating any force). Extended braking control is used with the modifications described below.

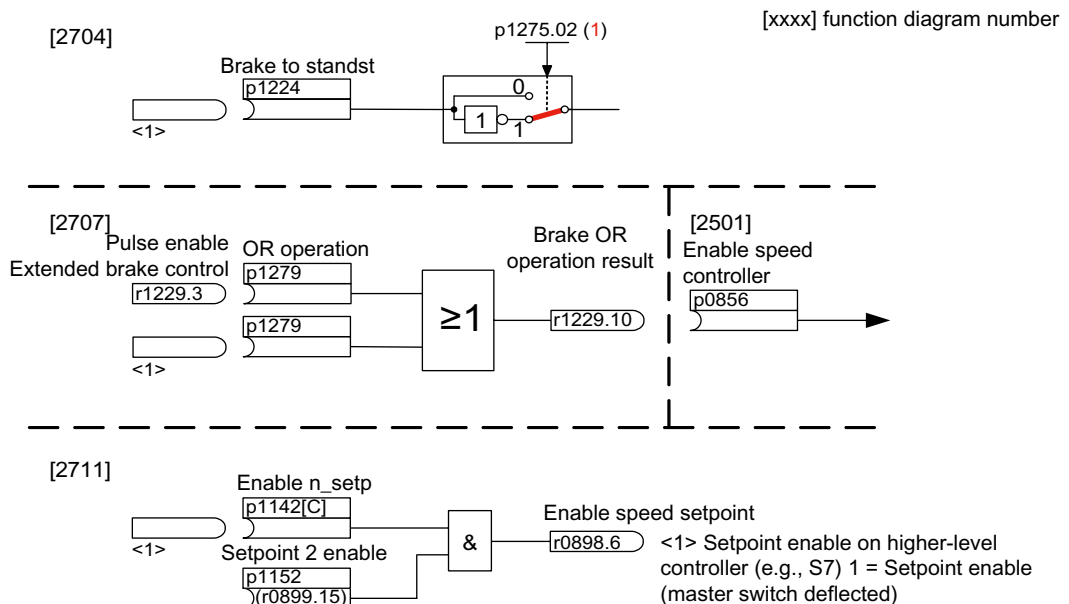


Figure 9-13 Example: Service brake on a crane drive

9.4.4 Extended monitoring functions

Description

The "extended monitoring functions" function module enables additional monitoring functions:

- Speed setpoint monitoring: $|n_setp| \leq p2161$
- Speed setpoint monitoring: $n_set > 0$
- Load monitoring

Description of load monitoring

This function monitors power transmission between the motor and the working machine. Typical applications include V-belts, flat belts, or chains that loop around the belt pulleys or cog wheels for drive and outgoing shafts and transfer the peripheral speeds and forces. Load monitoring can be used here to identify blockages in the working machine and interruptions to the power transmission.

During load monitoring, the current speed/torque curve is compared with the programmed speed/torque curve (p2182 – p2190). If the current value is outside the programmed tolerance bandwidth, a fault or alarm is triggered depending on parameter p2181. The fault or alarm message can be delayed by means of parameter p2192 to prevent false alarms caused by brief transitional states.

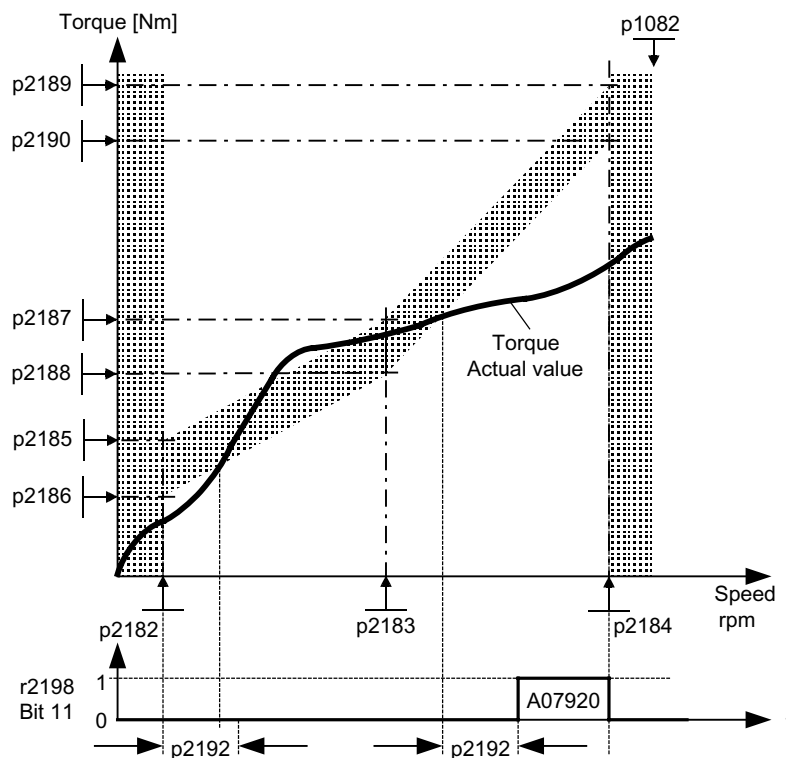


Figure 9-14 Load monitoring (p2181 =1)

Commissioning

The "extended monitoring functions" function module can be activated by running the commissioning wizard. Parameter r0108.17 indicates whether it has been activated.

Function diagram

FD 8010	Speed messages
FD 8013	Load monitoring

Parameters

- p2150 Hysteresis speed 3
- p2151 Cl: Speed setpoint
- p2161 Speed threshold 3
- p2181 Load monitoring, response
- p2182 Load monitoring, speed threshold 1
- p2183 Load monitoring, speed threshold 2
- p2184 Load monitoring, speed threshold 3
- p2185 Load monitoring, speed threshold 1 upper
- ...
- p2190 Load monitoring, speed threshold 3 lower
- p2192 Load monitoring, delay time
- r2198.4 BO: ZSW monitoring 2, $|n_setp| \leq p2161$
- r2198.5 BO: ZSW monitoring 2, $n_setp < 0$

9.4.5 Closed-loop position control

Description

The "Closed-loop position control" function module includes:

- Actual position value preparation (including subordinate measuring probe evaluation and reference mark search)
- Position controller (including limitation, adaptation and pre-control calculation)
- Monitoring (including zero-speed, positioning, dynamic following error monitoring system and cam signals)
- Position tracking of the load gearbox (motor encoder) when using absolute encoders for rotary axes (modulo)

Actual position value calculation for distance-coded measuring systems is not yet available.

Commissioning

The "Closed-loop position control" function module can be activated using the drive characteristics dialog.

When the "basic positioner" function module ($r0108.4 = 1$) is activated, the "closed-loop position control" function module ($r0108.3$) is automatically activated.

The current configuration can be checked in parameter $r0108.3$.

The position controller can be parameterized in a user-friendly fashion using the screen forms in STARTER.

The "closed-loop position control" function module is essential for operating the basic positioner.

Note

If the "position control" function module is active, and to optimize the speed controller, a function generator signal is interconnected to the speed controller input $p1160$, then the position controller monitoring functions respond.

To prevent this from happening, the position controller must be disabled ($p2550 = 0$) and tracking mode must be activated ($p2655 = 1$, for control using PROFIdrive telegram 110 $PosSTW.0 = 1$). In this way, the monitoring functions are switched off and the position setpoint is tracked.

Function diagram

FD 4010	Actual position value preparation
FD 4015	Position controller
FD 4020	Zero-speed / positioning monitoring
FD 4025	Dynamic following error monitoring, cam controllers

9.4.5.1 Actual position value preparation

Description

Position actual value conditioning prepares the actual position value in a neutral length unit LU. For this purpose, the function block uses the Gn_XIST1, Gn_XIST2, Gn_STW and Gn_ZSW encoder interfaces available in the encoder evaluation/motor controller. These simply provide the position data in encoder bars and fine resolution (increments).

The position actual value is conditioned, regardless of whether the position controller is enabled immediately after the system has booted, as soon as valid values are received via the encoder interface.

Parameter p2502 (encoder assignment) defines the encoder (1, 2 or 3) used to record the actual position value.

The following connection is run automatically after assignment:

- p0480[0] (G1_STW) = encoder control word r2520[0]
- p0480[1] (G2_STW) = encoder control word r2520[1]
- p0480[2] (G3_STW) = encoder control word r2520[2]

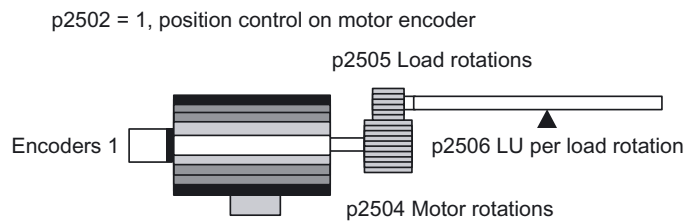


Figure 9-15 Position actual value conditioning with rotary encoders

The link between the physical variables and the neutral length unit LU is established via parameter p2506 (LU per load revolution) for rotary encoders. Parameter p2506 along with p2504, p2505 reflect the link between encoder increments and the neutral length unit LU.

Example:

Rotary encoder, ball screw with a pitch of 10 mm/revolution. 10 mm should have a resolution of 1 μm (i.e. 1 LU = 1 μm)

-> One load revolution corresponds to 10000 LU

-> p2506 = 10000

Note

The effective actual value resolution is obtained from the product of the encoder pulses (p0408) and the fine resolution (p0418) and a measuring gear that is possibly being used (p0402, p0432, p0433).

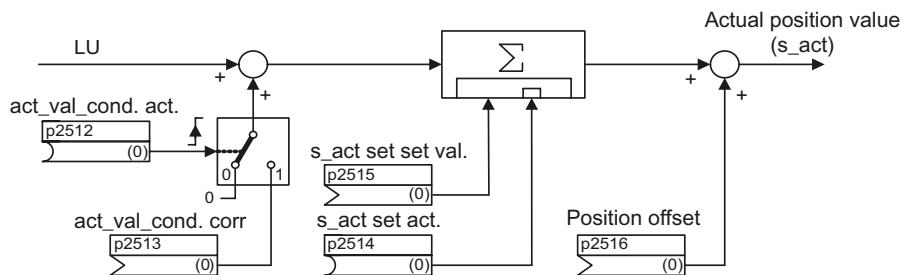



Figure 9-16 Position actual value conditioning

An offset can be undertaken using connector input p2513 (actual position value conditioning offset) and a positive edge at the binector input p2512 (activate offset). When the "basic positioner" function module is activated, p2513 is automatically connected with r2685 (EPOS offset) and p2515 with r2684.7 (activate offset). This interconnection enables modulo offset by EPOS, for example.

p2516 can be used to switch in position offset. Using EPOS, p2516 is automatically interconnected to r2667. Backlash compensation is implemented using this interconnection.

Using the connector input p2515 (position setting value) and a "1" signal at binector input p2514 (set position actual value), a position setting value can be entered.

 WARNING
<p>When the actual position value is set (p2514 = "1" signal), the actual position value of the position controller is kept at the value of connector p2515 as standard.</p> <p>Incoming encoder increments are not evaluated. A difference in position cannot be compensated for in this situation.</p>

An inversion of the actual position value resulting from the encoder is undertaken using parameter p0410. An inversion of the axis motion can be entered using a negative value in p2505.

Indexed actual value acquisition

The indexed position actual value acquisition permits e.g. length measurements on parts as well as the detection of axis positions by a higher-level controller (e.g. SIMATIC S7) in addition to the position control e.g. of a belt conveyor.

Two more encoders can be operated in parallel with the encoders for actual value conditioning and position control in order to collect actual values and measured data.

The indexed acquisition of actual values can preprocess a position actual value at each of the three encoder outputs. The parameter p2502[0...3] is used to select the encoder evaluation for position control.

The parameters of the indexed actual value acquisition are indexed four times. The indexes 1..3 are assigned to the encoder evaluations 1..3. The index 0 is assigned to position control.

The parameter r2521[0...3] can be used to retrieve the current actual values of all connected encoders. For example, the position actual value for position control in r2521[0] is identical with the value r2521[1] if the position control uses encoder evaluation 1. The signal source for a position offset can be set via parameter p2516[0..3].

The absolute encoder adjustment is initiated via p2507[0...3].2, and its successful completion is reported via p2507[0...3].3. The signal source "Reference point coordinate for the position controller" p2598[0] is interconnected with p2599 during basic positioning. The other signal sources are not interconnected in the standard configuration.

The measuring probe evaluation can be enabled for the encoder evaluation x, which is not assigned to position control, via p2509[x]. The signal sources are assigned via p2510[0...3], the edge evaluation is set via p2511[0...3]. The measured value is then available in r2523[x] if the status word for encoder x (encoder 0: r2526.0..9, encoder1: 2627.0..2, encoder2: r2628.0..2, encoder3: r2529.0..2) has the "Valid measurement" bit set.

The current values of the position actual values of the different encoders can be read out via parameter r2521[0...3]. These position actual values can be corrected with a signed value from p2513[0...3] after a 0/1 signal from the signal source in p2512[0...3].

In addition, the velocity actual value (r2522[0...3]) and the position offset for absolute encoders p2525[0...3] can be processed for each encoder by the higher-level controller.

Load gear position tracking

Position tracking enables reproduction of the motor position when gears are used. It can also be used to extend the position area.

Position tracking for load gear functions in the same way as position tracking for the measuring gear (see "Position tracking/Measuring gear"). Position tracking is activated via parameter p2720.0 = 1. The position tracking of the load gear, however, is only relevant for the motor encoder (encoder 1). The load gear ratio is entered via parameters p2504 and p2505. Position tracking can be activated with rotary axes (modulo).

Position tracking for the load gear can only be activated once for each motor data set MDS.

The load position actual value in r2723 (must be requested via Gn_STW.13) is made up of the following information:

- Encoder pulses per revolution (p0408)
- Fine resolution per revolution (p0419)
- Virtual number of stored revolutions of a rotary absolute encoder (p2721)
- Load gear ratio (p2504/p2505)
- Measuring gear ratio (p0433/p0432), if p0411.0 = 1

Note

The total of p0408, p0419 and p2721 is limited to 32 bits.

Example: Absolute encoder can count 8 encoder revolutions (p0421 = 8)

Note

Load gear problems and solutions, see example in "Position tracking/Measuring gear".

Position range extension example

With absolute encoders without position tracking, it must be ensured that the traversing range is 0 smaller than half the encoder range, because, beyond this range, no unique reference remains after switch-on and switch-off (see description on parameter p2507). This traversing range can be extended using the virtual multiturn (p2721).

For reasons of presentation, an absolute encoder was selected in the figure below that can represent 8 encoder revolutions (p412 = 8). The parameter p2721 is pre-assigned a value of 512. To simplify the presentation, p2721=24 as well as a setting of p2504 = p2505 =1 (gear factor = 1) were selected.

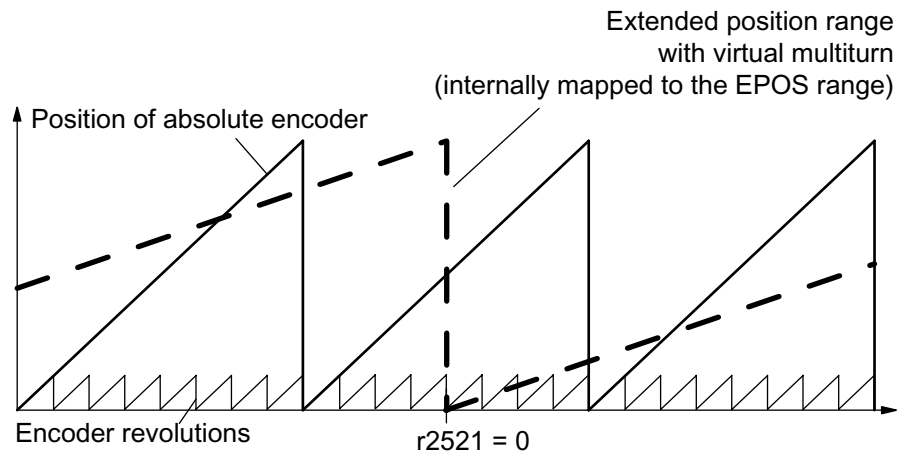


Figure 9-17 Load gear position tracking (p2721 = 24)

In this example, this means:

- Without position tracking, the position for +/- 4 encoder revolutions about r2521 = 0 LU can be reproduced.
- With position tracking, the position for +/- 12 encoder revolutions can be reproduced (p2721 = 24).

Practical example:

For a linear axis, the value for p2721 is set to 262144 for an encoder with p0421 = 4096. That means, +/- 131072 encoder revolutions or load revolutions can be reproduced in this way.

For a rotary axis, a value for p2721 = p0421 is set for an encoder.

Configuration of the load gear (p2720).

The following points can be set by configuring this parameter:

- p2720.0: Activation of position tracking
- p2720.1: Setting the axis type (linear axis or rotary axis)
Here, a rotary axis refers to a modulo axis (modulo offset can be activated through higher-level control or EPOS). With a linear axis, position tracking is mainly used to extend the position area (see section: Virtual multiturn encoder (p2721)).
- p2720.2: Reset position

The position values stored in a non-volatile fashion are reset for the following events:

- If encoder replacement is detected.
- If the configuration of the encoder data set (EDS) is modified.
- If the absolute encoder is re-calibrated.

Note

If position tracking of the load gear is activated after an adjustment (p2507=3) via parameter p2720[0] = 1 (position gear load tracking) has been made, the adjustment will be reset.

Further adjustment of the encoder while the position tracking is activated will cause the load gear position to be reset (overflow).

The permissible range of position tracking is mapped to the reproducible EPOS encoder range.

It is possible to activate position tracking for several DDS.

Virtual multiturn encoder (p2721)

The virtual multiturn resolution is used to set the number of resolvable motor rotations for a rotary absolute encoder with activated position tracking. It can be edited only for rotary axes.

With a rotary absolute encoder (p0404.1 = 1) with activated position tracking (p2720.0 = 1), p2721 can be used to enter a virtual multiturn resolution.

For rotary axes, the virtual multiturn resolution (p2721) is preset to the value of the multiturn resolution of the encoder (p0421) but may be changed.

For linear axes, the virtual multiturn resolution (p2721) is preset to the multiturn resolution of the encoder (p0421) extended by 6 bits (max. overflows 32 positive/negative)

If, as a result of extension of the multiturn information, the displayable area of r2723 (32 bits) is exceeded, the fine resolution (p0419) must be reduced accordingly.

Tolerance window (p2722)

After switching on, the difference between the stored position and the actual position is ascertained and, depending on the result, the following is triggered:

- Difference within the tolerance window -> the position is reproduced based on the current actual encoder value.
- Difference outside the tolerance window -> an appropriate message (F07449) is output.

The tolerance window is preset to quarter of the encoder range and can be changed.

 CAUTION
--

The position can only be reproduced if, in the powered-down state, if the encoder was moved through less than half of the range that it can represent. For the standard EQN1325 encoder, this is 2048 revolutions or half a revolution for singleturn encoders.

Note

The ratio stamped on the gear rating plate is often just a rounded-off value (e.g.1:7.34). If, for a rotary axis, it is not permissible to have any long-term drift, then the actual ratio of the gear teeth must be requested from the gear manufacturer.

Several drive data sets

As of FW version V2.6, position tracking of the load gear can be activated in several drive data sets.

- The load gear is DDS-dependent.
- Position tracking of the load gear is calculated only for the active drive data set and is EDS-dependent.
- If position tracking is to be continued in different drive data sets with the same mechanical relationships and the same encoder data sets, it must be activated explicitly in all relevant drive data sets. Possible applications for drive data set changeover with continued position tracking:
 - Star/delta changeover
 - Different ramp-up times/controller settings
- On changeover of the drive data set where the gear is changed, position tracking is restarted, i.e. the behavior after changeover is the same as after a POWER ON.
- For identical mechanical relationships and the same encoder data set, DDS changeover has no effect on the calibration status and reference point status.

Restrictions

- If an encoder data set is used as encoder 1 in several drive data sets with different gears, it is not possible to activate position tracking there. If an attempt is nevertheless made to activate position tracking, fault F07555 (drive encoder: configuration position tracking) is issued with fault value 03 hex.
Generally, it is checked whether the load gear is identical in all DDS in which this encoder data set is used.
Load gear parameters p2504[D], p2505[D], p2720[D], p2721[D] and p2722[D] must be identical in this case.
- If an encoder data set is used as a motor encoder with load position tracking in one DDS and as an external encoder in another DDS, position tracking is restarted on changeover, i.e. the behavior after changeover is the same as after a POWER ON.
- If position tracking is reset in one drive data set, this affects all drive data sets in which this encoder data set is used.
- The maximum permissible movement of an axis in an inactive drive data sets is half the encoder range (see p2722: tolerance window).

The table below describes the changeover behavior on transition from one DDS to another. A changeover is always executed by DDS0.

Table 9- 9 DDS changeover with load gear position tracking

DDS	p0186 (MDS)	p0187 (encoder_1)	p0188 (encoder_2)	p0189 (encoder_3)	Encoder for position control p2502	Mechan. relationships p2504/ p2505/ p2506 or p2503	Load gear position tracking	Changeover response
0	0	EDS0	EDS1	EDS2	encoder_1	xxx	enabled	---
1	0	EDS0	EDS1	EDS2	encoder_1	xxx	enabled	Switching during pulse inhibit or operation has no effect
2	0	EDS0	EDS1	EDS2	encoder_1	yyy	disabled	Pulse inhibit/operation: Encoder adjustment and referencing bit ²⁾ are reset. Position tracking is no longer calculated; it is not reset until there is a new encoder adjustment.
3	0	EDS0	EDS1	EDS2	encoder_2	xxx	enabled	Pulse inhibit/operation: Position tracking is continued and referencing bit ²⁾ is reset.
4	0	EDS0	EDS3	EDS2	encoder_2	xxx	enabled	
5	1	EDS4	EDS1	EDS2	encoder_1	xxx	enabled	
6	2	EDS5	EDS6	EDS7	encoder_1	zzz	enabled	
7	3	EDS0	EDS1	EDS2	encoder_1	xxx	enabled	MDS changeover alone during pulse inhibit or operation has no effect.
8	0	EDS0	EDS1	EDS2	encoder_1	xxx	disabled	Pulse inhibit/operation: Position tracking for EDS0 (of the DDS0) newly set ¹⁾ and reference bit ³⁾ is reset.
9	4	EDS6	EDS0	EDS2	encoder_1	www	Not relevant	Pulse inhibit/operation: Position tracking for EDS (of the DDS0) newly set ¹⁾ and reference bit ³⁾ is reset.

¹⁾ Is newly initiated means: For absolute encoders, the absolute value is newly read out.

²⁾ For absolute encoders, r2684.11 ("Reference point set") is reset, and also the status of the adjustment (p2507).

³⁾ For absolute encoders, r2684.11 ("Reference point set") is reset and the adjustment status (p2507) is not additionally reset because the EDS differs from the original one.

www, xxx, yyy, zzz: different mechanical conditions

Function diagram

FP 4010	Position actual value conditioning
FP 4704	Position and temperature sensing, encoders 1...3
FP 4710	Speed act. value and pole pos. sens., motor enc. (encoder 1)

Parameter

- p2502 LR encoder assignment
- p2503 LR length unit LU per 10 mm
- p2504 LR motor/load motor revolutions
- p2505 LR motor/load load revolutions
- p2506 LR length unit LU per load revolution
- r2520 CO: LR position actual value conditioning encoder control word
- r2521 CO: LR actual position value
- r2522 CO: LR actual velocity value
- r2523 CO: LR measured value
- r2524 CO: LR LU/revolutions
- r2525 CO: LR encoder adjustment offset
- r2526 CO/BO: LR status word
- p2720 Load gear configuration
- p2721 Load gear, absolute encoder, rotary revolutions, virtual
- p2722 Load gear, position tracking, tolerance window
- r2723 CO: Load gear absolute value
- r2724 CO: Load gear position difference

9.4.5.2 Closed-loop position controller

Description

The position controller is a PI controller. The P gain can be adapted using the product of connector input p2537 (position controller adaptation) and parameter p2538 (Kp).

Using connector input p2541 (limit), the speed setpoint of the position controller can be limited without pre-control. This connector input is pre-connected with connector output p2540.

The position controller is enabled by an AND link of the binector inputs p2549 (position controller 1 enable) and p2550 (position controller 2 enable).

The position setpoint filter (p2533 position setpoint filter time constants) is a PT1 element, the balancing filter a dead time element (p2535 balancing filter speed feedforward control (dead time)) and PT1 member (p2536 balancing filter speed feedforward control (PT1)). The speed feedforward control p2534 (speed feedforward control factor) can be deactivated using the value 0.

Note

We recommend that only experts use the functions of the position controller without using the basic positioner.

Function diagram

FD 4015 Position controller

Parameters

- p2533 LR position setpoint filter time constants
- p2534 LR speed feedforward control factor
- p2535 LR speed feedforward control balancing filter dead time
- p2536 LR speed feedforward control balancing filter PT1
- p2537 CI: LR position control adaptation
- p2538 LR proportional gain
- p2539 LR integral time
- p2540 CO: LR position controller output speed limit
- p2541 CI: LR position controller output speed limit signal source

9.4.5.3 Monitoring functions

Description

The position controller monitors the standstill, positioning and following error.

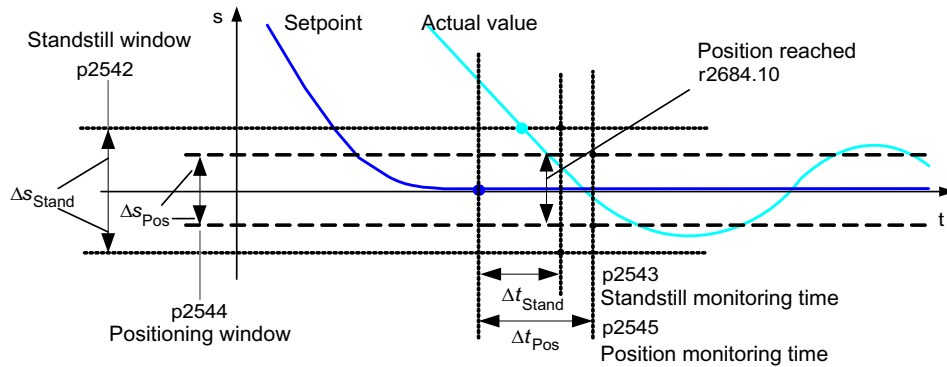


Figure 9-18 Zero-speed monitoring, positioning window

Zero-speed monitoring

Zero-speed monitoring is activated via binector inputs p2551 (setpoint stationary) and p2542 (zero-speed window). If the zero-speed window is not reached once the monitoring time (p2543) has lapsed, fault F07450 is triggered.

Zero-speed monitoring is deactivated with value "0" in p2542. The zero-speed window should be greater than or equal to the positioning window ($p2542 \geq p2544$). The zero-speed monitoring time should be less than or equal to the positioning monitoring time ($p2543 \leq p2545$).

Position monitoring

Positioning monitoring is activated via binector inputs p2551 (setpoint stationary), p2554 = "0" (travel command not active) and p2544 (positioning window). Once the monitoring time (p2545) has elapsed, the positioning window is checked once. If this is not reached, fault F07451 is triggered.

Positioning monitoring can be deactivated with the value "0" in p2544. The zero-speed window should be greater than or equal to the positioning window ($p2542 \geq p2544$). The zero-speed monitoring time should be less than or equal to the positioning monitoring time ($p2543 \leq p2545$).

Following error monitoring

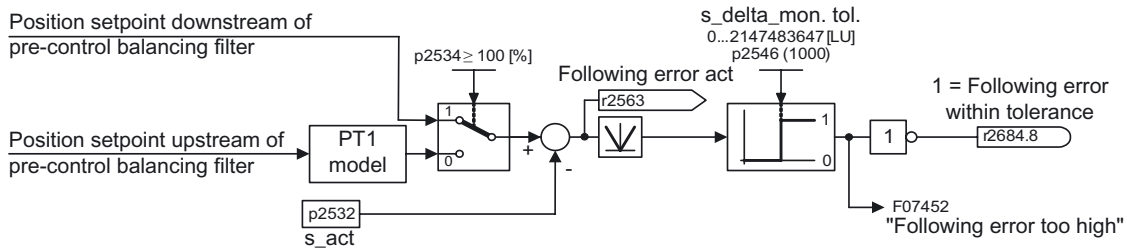


Figure 9-19 Following error monitoring

Following error monitoring is activated via p2546 (following error tolerance). If the value specified for the following error (r2563) is greater than p2546, fault F07452 is triggered and bit r2648.8 is reset.

Cam controllers

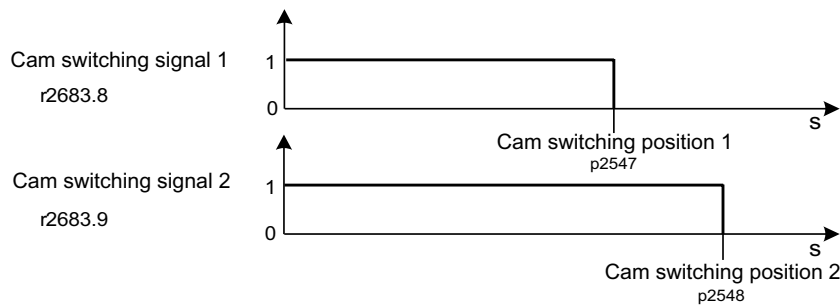


Figure 9-20 Cam controllers

The position controller has two cam controllers. When cam position p2547 or p2548 is overtraveled, cam signals r2683.8 or r2683.9 are reset.

Function diagram

FD 4020	Zero-speed / positioning monitoring
FD 4025	Dynamic following error monitoring, cam controller

Parameters

- p2530 CI: LR setpoint position
- p2532 CI: LR actual position value
- p2542 LR zero-speed window
- p2543 LR zero-speed monitoring time
- p2544 LR positioning window
- p2545 LR position monitoring time
- p2546 LR dynamic following error monitoring tolerance
- p2547 LR cam switching position 1
- p2548 LR cam switching position 2
- p2551 BI: LR setpoint message present
- p2554 BI: LR travel command message active
- r2563 CO: LR latest following error
- r2683.8 Actual position value <= cam switching position 1
- r2683.9 Actual position value <= cam switching position 2
- r2684 CO/BO: EPOS status word 2

9.4.5.4 Measurement probe evaluation and reference mark search

Description

Binector inputs p2508 (activate reference mark search) and p2509 (activate measurement probe evaluation) can be used to trigger and run the "measurement probe evaluation" and "reference mark search" functions. Binector inputs p2510 (measurement probe selection) and p2511 (measurement probe edge evaluation) define the mode for measurement probe evaluation.

The probe signals are recorded via the encoder encoder status and control word. To speed up signal processing, direct measuring probe evaluation can be activated by selecting the input terminals for probes 1/2 via p2517 and p2518. Measuring probe evaluation is carried out in the position controller cycle, whereby the set send clock cycle of the controller (r2064[1]) must be an integer multiple of the position controller cycle (p0115[4]).

The system outputs a message if the same probe input is already being used (see also p0488, p0489, p0580, and p0680).

The appropriate function is started using a 0/1 edge at the appropriate input (p2508 (activate reference mark search) or p2509 (activate measuring probe evaluation)) via the encoder control word. Status bit r2526.1 (reference function active) reports the activity of the function (feedback from sensor status word). Status bit r2526.2 (measurement value valid) indicates the presence of the measurement value required r2523 (position for reference mark or measurement probe).

Once the function is complete (position determined for reference mark or measurement probe), r2526.1 (reference function active) and r2526.2 (measurement valid) continue to remain active and the measurement is provided by r2523 (reference measurement) until the

corresponding input p2508 (activate reference mark searches) or p2509 (activate measurement probe evaluation) is reset (0 signal).

If the function (reference mark search or measuring probe evaluation) has still not been completed and the corresponding input p2508 or p2509 is reset, then the function is interrupted via the encoder control word and status bit r2526.1 (reference function active) is reset via the encoder status word.

Setting the two binector inputs p2508 and p2509 at the same time results in the active function being aborted and/or no functions being started. This is indicated by alarm A07495 "reference function aborted" and remains active until the activations at the binector inputs are reset. The alarm is also generated if a fault is signaled during an activated function (reference mark search or measurement probe evaluation) by the encoder status word.

If the "position controller" function module is selected, these parameters (p2508 to p2511) are preassigned with "0". If the "basic positioner" function module is selected, the "reference mark search" (for search for reference point) and "measurement probe evaluation" (for the flying referencing function) functions are initiated by the "basic positioner" function module and feedback (r2526, r2523) returned to this.

Function diagram

FD 4010	Actual position value preparation
FD 4720	Encoder interface, receive signals, encoder 1...3
FD 4730	Encoder interface, send signals, encoder 1...3

Parameters

- p2508 BI: LR activate reference mark searches
- p2509 BI: LR activate measurement probe evaluation
- p2510 BI: LR measurement probe evaluation selection
- p2511 BI: LR measurement probe evaluation edge
- p2517 LR direct probe 1 input terminal
- p2518 LR direct probe 2 input terminal
- r2523 CO: LR measured value
- r2526 CO/BO: LR status word

9.4.6 Basic positioner

Description

The "basic positioner" function module (EPOS) is used for the absolute/relative positioning of rotary axes (modulo) with motor encoders (indirect measuring system) or machine encoders (direct measuring system).

User-friendly configuration, commissioning, and diagnostic functions are also available in STARTER for the basic positioner functionality (graphic navigation). A control panel is available in STARTER for the basic positioner and variable speed operation, which can be used to control the functionality via the PC/PG for commissioning or diagnostics.

When the basic positioner is activated ($r0108.4 = 1$), position control ($r0108.3 = 1$) must also be activated. This occurs automatically when the basic positioner is activated by the commissioning Wizard in STARTER. The required "internal connections" (BICO technology) are also established automatically.

 CAUTION
--

The basic positioner requires the position controller functions. The BICO interconnections established by the basic positioner must be changed by experienced users only.

As a result, the position control functions are also available (e.g. zero-speed monitoring, position monitoring, dynamic following error monitoring, cam controllers, modulo function, measurement probe evaluation). See "Closed-loop position control".

In addition, the following functions can be carried out using the "basic positioner" function module:

- Mechanical system (is assigned to position controller in the STARTER)
 - Backlash compensation
 - Modulo offset
 - Position tracking of the load gearbox (motor encoder) with absolute encoders
- Limitations
 - Velocity profile limitations
 - Traversing range limits
 - Jerk limit

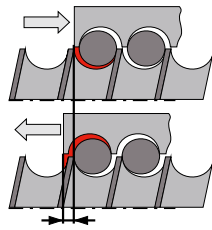
- Homing or adjustment
 - Setting reference point (with stationary axis)
 - Homing
(separate mode including reversing cam functionality, automatic reversal of direction, homing to "cams and encoder zero mark" or only "encoder zero mark" or "external zero mark (BERO)")
 - Flying referencing
(superimposed homing possible during "normal" traversing with the aid of the measurement probe evaluation (normally evaluation of a BERO, for example). Superimposed function for the modes "Jog", "Direct setpoint specification / MDI" and "Traversing blocks".
 - Homing with incremental measuring systems
 - Absolute encoder adjustment
- Traversing blocks mode (64 traversing blocks)
 - Positioning by means of traversing blocks stored in the device, including continuation conditions and specific jobs for previously homed axis
 - Traversing block editor using STARTER
 - A traversing block contains the following information:
 - Job number
 - Task (e.g. position, wait, GOTO set jump, set binary outputs)
 - Motion parameters (target position, override speed for acceleration and deceleration)
 - Mode (e.g.: skip block, continuation conditions such as "Continue_with_stop" and "Continue_flying")
 - Job parameters (e.g. wait time, block step conditions)
- Direct setpoint specification mode (MDI)
 - Positioning (absolute, relative) and setting-up (endless closed-loop position control) using direct setpoint inputs (e.g. via the PLC or process data)
 - It is always possible to influence the motion parameters during traversing (on-the-fly setpoint acceptance) as well as on-the-fly change between the Setup and Positioning modes.
- Jog mode
 - Position-controlled traversing of the axis with the switchable modes "Endless position-controlled" or "Incremental jog" (to traverse an "increment")
- Standard PROFIdrive positioning telegrams are available (telegrams 7, 9 and 110), the selection of which automatically establishes the internal "connection" to the basic positioner.
- Control using PROFIdrive telegrams 7 and 110.

Commissioning

The "basic positioner" function module can be activated by running the commissioning Wizard. Parameter r0108.4 indicates whether the function module has been activated.

9.4.6.1 Mechanical system

Description



Backlash:
p2583

Figure 9-21 Backlash compensation

When mechanical force is transferred between a machine part and its drive, generally backlash occurs. If the mechanical system was to be adjusted/ designed so that there was absolutely no play, this would result in high wear. Thus, backlash (play) can occur between the machine component and the encoder. For axes with indirect position sensing, mechanical backlash results in a falsification of the traversing distance, as, at direction reversal, the axis travels either too far or not far enough corresponding to the absolute value of the backlash.

Note

The backlash compensation is active, after

- the axis has been referenced for incremental measuring systems
- the axis has been adjusted for absolute measuring systems

In order to compensate the backlash, the determined backlash must be specified in p2583 with the correct polarity. At each direction of rotation reversal, the axis actual value is corrected dependent on the actual traversing direction and is displayed in r2667. This value is converted into the actual position value by p2516 (position offset).

If a stationary axis is referenced by setting a reference point or an adjusted axis is activated with the absolute encoder, the setting of parameter p2604 (reference point approach start direction) is relevant to activating the compensation value.

Table 9- 10 Activation of compensation value depending on p2604

p2604 (start direction)	Travel direction	Activation of the compensation value
0	positive	None
	negative	immediately
1	positive	immediately
	negative	None

Modulo offset

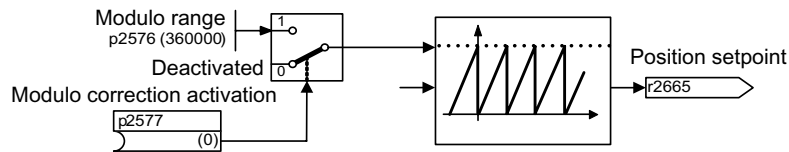


Figure 9-22 Modulo offset

A modulo axis has an unrestricted travel range. The range of values for the position repeats following a particular parameterizable value (the modulo range and/or axis cycle), e.g. following one revolution: $360^\circ \rightarrow 0^\circ$. The modulo range is set in parameter p2576, the offset is activated with parameter p2577. The modulo offset is undertaken at the setpoint end. This is provided with the correct prefix via the connector output r2685 (offset value) in order to offset the actual position value accordingly. Activation of the offset is initiated by a rising edge of binector output r2684.7 (activate offset) of the "basic positioner" function module (r2685 (offset value) and r2684.7 (activate offset) are already linked to the corresponding binector/connector input of position actual value conditioning). Absolute positioning details (e.g. in a traversing block) must always be within the modulo range. The traversing range cannot be restricted by software limit switches.

With active modulo offset and the application of absolute encoders, as a result of potential encoder overflows, it must be ensured that there is an integer ratio v between the multiturn resolution and the modulo range.

The ratio v can be calculated as follows:

1. Motor encoder without position tracking:

$$v = (p0421 \times p2506 \times p0433 \times p2505) / (p0432 \times p2504 \times p2576)$$
2. Motor encoder with position tracking for measuring gear:

$$v = (p0412 \times p2506 \times p2505) / (p2504 \times p2576)$$
3. Motor encoder with position tracking for load gear:

$$v = (p2721 \times p2506 \times p0433) / (p0432 \times p2576)$$
4. Motor encoder with position tracking for load and measuring gear:

$$v = (p2721 \times p2506) / p2576$$
5. Direct encoder without position tracking:

$$v = (p0421 \times p2506 \times p0433) / (p0432 \times p2576)$$
6. Direct encoder with position tracking for measuring gear:

$$v = (p0412 \times p2506) / p2576$$

With position tracking it is recommended to change p0412 or p2721.

Function diagram

FP 3635	Interpolator
FP 4010	Position actual value conditioning

Parameter

- p2576 EPOS modulo offset modulo range
- p2577 BI: EPOS modulo offset activation
- p2583 EPOS backlash compensation
- r2684 CO/BO: EPOS status word 2
- r2685 CO: EPOS offset value

9.4.6.2 Limitations

Description

The velocity, acceleration and delay can be restricted and the software limit switches and stop cams set.

The following restrictions exist:

- Velocity profile limitations
 - Maximum speed (p2571)
 - Maximum acceleration (p2572) / maximum delay (p2573)
- Traversing range limits
 - Software limit switches (p2578, p2579, p2580, p2581, p2582)
 - STOP cams (p2568, p2569, p2570)
- Jerk limit
 - Jerk limitation (p2574)
 - Activation of jerk limitation (p2575)

Maximum velocity

The maximum velocity of an axis is defined using parameter p2571. The velocity should not be set to be greater than the maximum speeds in r1084 and r1087.

The drive is limited to this velocity if a higher velocity is specified or programmed via the override (p2646) for the reference point approach or is programmed in the traversing block.

Parameter p2571 (maximum velocity) defines the maximum traversing velocity in units of 1000 LU/min. Changing the maximum speed restricts the velocity of an active traversing block.

This restriction is only effective in positioning mode during:

- Jog mode
- Traversing block processing
- Direct setpoint specification/MDI for positioning/setting up
- Reference point approach

Maximum acceleration/delay

Parameters p2572 (maximum acceleration) and p2573 (maximum delay) define the maximum acceleration and maximum delay. The unit in both cases is 1000 LU/s².

Both values are relevant during:

- Jog mode
- Traversing block processing
- Direct setpoint specification/MDI for positioning and setting up
- Reference point approach

The parameters are of no effect if faults with the fault reactions OFF1 / OFF2 / OFF3 arise.

In "traversing blocks" operating mode, the acceleration and/or delay can be set in integer stages (1 %, 2 % to 100 %) of the maximum acceleration and delay. In "direct setpoint specification/MDI for positioning and setting up" operating mode, the acceleration/delay override (assignment of 400Hex = 100 %) is specified

Note

A maximum acceleration and/or delay dependent on current velocity (zigzag acceleration) is not supported.

Note

When using the PROFIdrive message frame 110, the velocity override is already connected and has to be supplied by the message frame.

Software limit switch

The connector inputs p2578 (software limit switch, minus) and p2579 (software limit switch, plus) restrict the setpoint position if the following preconditions are satisfied:

- Software limit switches are activated (p2582 = "1")
- Reference point is set (r2684.11 = 1)
- Modulo offset is not active (p2577 = "0")

In their factory setting, the connector inputs are linked with connector output p2580 (software limit switch, minus) and/or p2581 (software limit switch, plus).

Stop output cams

A traversing range can be restricted firstly by software using software limit switches and secondly the traversing range can be limited by hardware. The function of the stop cams (hardware limit switches) is used for this purpose. The function of the stop cams is activated by the 1 signal on the binector input p2568 (activation of stop cams).

Once enabled, the activity of binector inputs p2569 (stop cam, minus) and p2570 (stop cam, plus) is checked. These are low active cams, i.e. they are active if the 0 signal is present at binector input p2569 or p2570.

When a stop cam (p2569 or p2570) becomes active, the current motion is stopped using the maximum delay (p2573) and the corresponding status bit r2684.13 (stop cam active, minus) or r2684.14 (stop cam active, plus) set.

If the stop cams are approached, only motion away from the stop cam is permitted (if both stop cams are active, motion cannot be undertaken). Motion away from the stop cam in the permitted travel direction is detected by the 0/1 edge and the corresponding status bits (r2684.13 and/or r2684.14) are therefore reset.

Jerk limit

Acceleration and deceleration can change suddenly if jerk limiting has not been activated. The diagram below shows the traversing profile when jerk limitation has not been activated.

The diagram shows that maximum acceleration (a_{max}) and deceleration (d_{max}) are effective immediately. The drive accelerates until the target speed (v_{target}) is reached and then switches to the constant velocity phase.

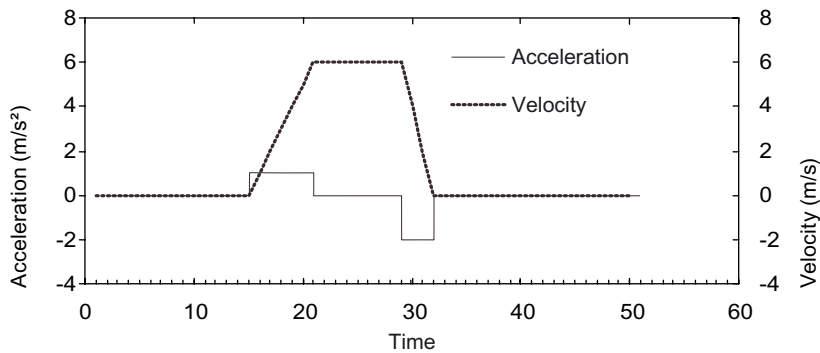


Figure 9-23 Jerk limitation deactivated

Jerk limitation can be used to achieve a ramp-like change of both variables, which ensures "smooth" acceleration and braking as shown in the diagram below. Ideally, acceleration and deceleration should be linear.

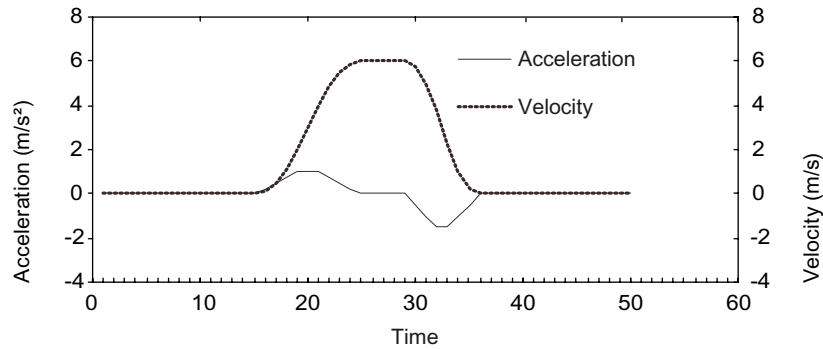


Figure 9-24 Jerk limitation activated

The maximum inclination (r_k) can be set in parameter p2574 ("Jerk limitation") in the unit LU/s^3 for both acceleration and braking. The resolution is $1000 LU/s^3$. To activate limiting permanently, set parameter p2575 ("Active jerk limitation") to 1. In this case, limitation cannot be activated or deactivated in traversing block mode by means of the command "JERK" as this would require parameter p2575 ("Active jerk limitation") to be set to zero. The status signal r2684.6 ("Jerk limitation active") indicates whether or not jerk limitation is active.

Limitation is effective:

- In jog mode
- When traversing blocks are processed
- When setpoints are defined directly/MDI for positioning and setup
- during referencing
- During stop responses due to alarms

Jerk limitation is not active when alarms occur with stop responses OFF1 / OFF2 / OFF3.

Function diagram

FD 3630 Traversing range limits

Parameters

- p2571 EPOS maximum speed
- p2572 EPOS maximum acceleration
- p2573 EPOS maximum delay
- p2646 CI: EPOS velocity override

Software limit switches:

- p2578 CI: EPOS software limit switch, minus signal source
- p2579 CI: EPOS software limit switch, plus signal source
- p2580 CO: EPOS software limit switch, minus
- p2581 CO: EPOS software limit switch, plus
- p2582 BI: EPOS software limit switch activation
- r2683 CO/BO: EPOS status word 1

STOP cams:

- p2568 BI: EPOS STOP cam activation
- p2569 BI: EPOS STOP cam, minus
- p2570 BI: EPOS STOP cam, plus
- r2684 CO/BO: EPOS status word 2

Jerk limit:

- p2574 EPOS jerk limitation
- p2575 BI: Jerk limitation activation

9.4.6.3 Referencing

Description

Once a machine has been switched on, the absolute dimensional reference to the machine's zero point must be established for positioning purposes. This procedure is referred to as referencing.

The following types of referencing are available:

- Setting reference point (all encoder types)
- Active referencing (reference point approach (p2597 = 0), with incremental encoder):
 - Referencing cam and encoder zero mark (p2607 = 1)
 - Encoder zero mark (p0495 = 0)
 - External zero mark (p0495 ≠ 0)
- Flying referencing (passive (p2597 = 1), with incremental encoder)
- Absolute encoder adjustment (with absolute value encoder)
- Flying referencing (passive (p2597 = 1), with absolute encoder)

A connector input is provided for the specification of reference point coordinates for all types of referencing. This allows e.g. for modification/specification by means of higher-level control. An adjustable parameter for this variable is however needed for the fixed specification of reference point coordinates. This adjustable parameter p2599 is connected to connector input p2598 as standard.

Note

Referencing of distance-coded zero marks is not supported.

Set reference point

The reference point can be set by a 0/1 edge on binector input p2596 (set reference point) if no other traversing block is active or has been interrupted by an interim stop. The current actual position of the drive is set here as the reference point using the coordinates specified by connector input p2598 (reference point coordinates). The setpoint (r2665) is adjusted accordingly.

This function also uses actual position value correction for the position controller (p2512 and p2513). Connector input p2598 is connected to adjustable parameter p2599 as standard. The binector input is not effective for the traversing task being presently executed.

Absolute encoder adjustment

Absolute encoders have to be adjusted during commissioning. Once the machine has been switched off, the encoder's position information is retained.

With the aid of the reference point coordinates in p2599 and by entering p2507 = 2, an offset value (p2525) is calculated and is then used to calculate the actual position value (r2521). Parameter p2507 reports calibration using a "3". Bit r2684.11 (reference point set) is also set to "1".

For permanent acceptance, the encoder adjustment offset (p2525) should be saved in a non-volatile manner (RAM to ROM).

CAUTION

During adjustment with the rotary absolute encoder, a range is aligned symmetrically around the zero point with half the encoder range within which the position is restored after switch off/on. If position tracking is deactivated (2720.0 = 0), only one encoder overflow is permitted to occur in this range (further details are given in chapter "Position controller -> Actual position value conditioning"). Once adjustment has been carried out, the range must not be exited because a unique reference between the actual encoder value and the mechanical components cannot be established outside the range.

If the reference point p2599 is in the encoder range, the actual position value is set in line with the reference point during adjustment. Otherwise, it is set to a corrected value in the encoder range.

Reference point approach of incremental measuring systems

The reference point approach (when using an incremental measuring system) is used to move the drive to its reference point. The entire referencing cycle is controlled and monitored by the drive.

Incremental measuring systems require the absolute dimensional reference to the machine's zero point to be established once a machine has been switched on. When the machine is switched on, the actual position value x0 is set to x0 = 0 if not referenced. The reference point approach can be used to move the drive to its reference point in a reproducible manner. The geometry gained with a positive start direction (p2604 = "0") is shown below.

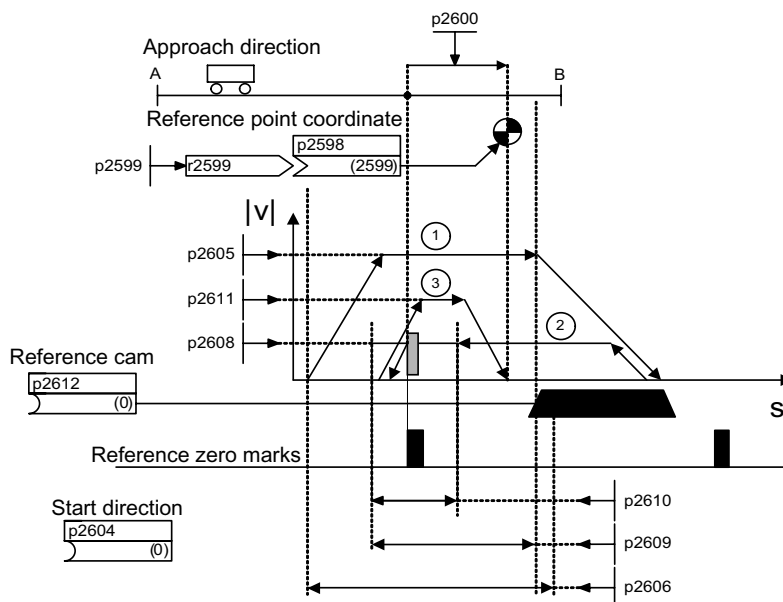


Figure 9-25 Example: reference point approach with reference cam

The signal on binector input p2595 (start referencing) is used to trigger travel to the reference cam (p2607 = 1) if reference point approach is selected at the same time (0 signal

at binector input p2597 (referencing type selection). The signal in binector input p2595 (start referencing) must be set during the entire referencing process otherwise the process is aborted. Once started, the status signal r2684.11 (reference point set) is reset.

During the entire reference point approach, monitoring of the software limit switches is inactive; only the maximum traversing range is checked. If necessary, monitoring of the software limit switches is reactivated once complete.

The velocity override set is only effective during the search for the reference cam (step 1). This ensures that the "cam end" and "zero mark" positions are always overrun at the same speed. If signal propagation delays arise during switching processes, this ensures that the offset caused during establishment of position is the same in each referencing process.

Axes which only have one zero mark over their entire traversing and/or modulo range, are identified using parameter p2607 = 0 (reference cam present). After starting the referencing process, synchronization to the reference zero marks is started straight away (see step 2) for these axes.

- **Reference point approach, step 1: travel to reference cam**

If there is no reference cam present (p2607 = 0), go to step 2.

When the referencing process is started, the drive accelerates at maximum acceleration (p2572) to the reference cam approach velocity (p2605). The direction of the approach is determined by the signal of binector input p2604 (reference point approach start direction).

The drive is informed that the reference cam has been reached by the signal at binector input p2612 (reference cam). The drive is then decelerated to a standstill using the maximum delay (p2573).

If a signal at binector input p2613 (reversing cam, minus) or at binector input p2614 (reversing cam, plus) is detected during the reference point approach, the search direction is reversed.

If the "reversing cam, minus" is approached in the positive direction, or the "reversing cam, plus" is approached in the negative direction, fault F07499 (EPOS: reversing cam approached with wrong traversing direction) is output. In this case, the wiring of the reversing cam (p2613, p2614) and/or the traversing direction for approaching the reversing cam must be checked.

The reversing cams are low active cams. If both reversing cams are active (p2613 = "0" and p2614 = "0"), the drive remains stationary. As soon as the reference cam is found, then synchronization to the reference zero mark is immediately started (refer to step 2).

If the axis leaves its start position and travels the distance defined in parameter p2606 (max. distance to reference cam) heading towards the reference cam without actually reaching the reference cam, the drive remains stationary and fault F07458 (reference cam not found) is issued.

When starting the referencing process, if the axis is already at the cam, it does not have to travel to the reference cam and instead synchronization to the reference zero mark is started straight away (see step 2).

Note

The velocity override is effective during the search for the cam. By changing the encoder data set, status signal r2684.11 (reference point set) is reset.

The cam switch must be able to deliver both a rising and a falling edge.

During the reference point approach when evaluating the sensor zero mark, the 0/1 edge is evaluated with increasing actual position values and the 1/0 edge with falling actual position values. Inversion of the edge evaluation is not possible at the sensor zero mark.

If the length measuring system has several zero marks which repeat at cyclic intervals (e.g. incremental, rotary measuring system), you must ensure that the cam is adjusted so that the same zero mark is always evaluated.

The following factors may impact on the characteristics of the "reference cam" control signal:

- Switching accuracy and time delay of reference cam switch
 - Position controller cycle of drive
 - Interpolation cycle of drive
 - Temperature sensitivity of machine's mechanical system
-

- **Reference point approach, step 2: Synchronization to reference zero mark (encoder zero mark or external zero mark)**

Reference cam available (p2607 = 1):

In step 2, the drive accelerates to the velocity specified in p2608 (zero mark approach velocity) in the direction opposite to that specified by binector input p2604 (reference point approach start direction). The zero mark is expected at distance p2609 (max. distance to zero mark). The search for the zero mark is active (status bit r2684.0 = "1" (reference point approach active)) as soon as the drive leaves the cam (p2612 = "0") and is within the tolerance band for evaluation (p2609 - p2610). If the position of the zero mark is known (encoder evaluation), the actual position of the drive can be synchronized using the zero mark.

The drive starts the reference point approach (see step 3). The distance traveled between the cam end and zero mark is displayed in parameter r2680 (difference between cam and zero mark).

Encoder zero mark (p0495 = 0), no reference mark present (p2607 = 0):

Synchronization to the reference zero mark begins as soon as the signal at binector input p2595 (start referencing) is detected. The drive accelerates to the velocity specified in parameter p2608 (zero mark approach velocity) in the direction specified by the signal of the binector input p2604 (reference point approach start direction).

The drive synchronizes to the first zero mark. and then starts to travel towards the reference point (see step 3).

Note

In this case the direction of approach to the encoder zero mark is the opposite to the axes with reference cams!

External zero mark present (p0495 ≠ 0), no reference cam (p2607 = 0):

Synchronization to an external zero mark begins as soon as the signal at binector input p2595 (start referencing) is detected. The drive accelerates to the velocity specified in parameter p2608 (zero mark approach velocity) in the direction specified by the signal of the binector input p2604 (reference point approach start direction).

The drive synchronizes to the first external zero mark (p0495). The drive continues at the same speed and travel to the reference point is started (see step 3).

Note

The velocity override is inoperative during this process.

Parameter p0495 (equivalent zero mark at input terminal) can be used to set an equivalent zero mark and to select the corresponding digital input. The 0/1 edge is evaluated with increasing actual position values and the 1/0 edge with falling actual position values as standard. This can be inverted for an equivalent zero mark using parameter p0490 (measurement probe or equivalent zero mark).

- **Reference point approach, step 3: travel to reference point**

Travel to the reference point is started when the drive has successfully synchronized to the reference zero mark (see step 2). Once the reference zero mark has been detected, the drive accelerates on-the-fly to the reference point approach velocity set in parameter p2611. The reference point offset (p2600), the distance between the zero mark and reference point, is extended.

Once the axis has reached the reference point, the actual and setpoint position value is set to the value specified at connector input p2598 (reference point coordinates) (connector input p2598 is linked to adjustable parameter p2599 as standard). The axis is then referenced and the status signal r2684.11 (reference point set) set.

Note

The velocity override is inoperative during this process.

If the braking distance is longer than the reference point offset or a direction reversal is required as a result of the selected reference point offset, then, after the reference zero mark has been detected, the drive initially brakes to standstill and then travels back.

Flying referencing

The "on-the-fly referencing" mode (also known as post-referencing), which is selected using a "1" signal at binector input p2597 (select referencing type), can be used in every mode (jogging, traversing block and direct setpoint input for positioning/setup) and is superimposed on the currently active mode. Flying referencing can be selected both with incremental and absolute measuring systems.

With "flying referencing" during incremental positioning (relative), you can select whether the offset value is to be taken into account for the travel path or not (p2603).

"Flying referencing" is activated by a 0/1 edge at binector input p2595 (start referencing). The signal in binector input p2595 (start referencing) must be set during the entire referencing process otherwise the process is aborted.

Status bit r2684.1 (passive/flying referencing active) is linked with binector input p2509 (activate measurement probe evaluation). It activates measurement probe evaluation. Binector inputs p2510 (measurement probe selection) and p2511 (measurement probe edge evaluation) can be used to set which measurement probe (1 or 2) and which measurement edge (0/1 or 1/0) is to be used.

The measurement probe pulse is used to supply connector input p2660 (referencing measurement value) with the measurement via parameter r2523. The validity of the measurement is reported to binector input p2661 (measurement valid feedback) via r2526.2.

Note

The following must always apply to the "Flying referencing mode" windows:

p2602 (outer window) > p2601 (inner window).

See function diagram 3614 for more information on the "Flying referencing mode" function.

The following then happens:

- If the drive has not yet been referenced, status bit r2684.11 (reference point set) is set to "1".
- If the drive has already been referenced, status bit r2684.11 (reference point set) is not reset when starting flying referencing.
- If the drive has already been referenced and the position difference is less than the inner window (p2601), the old actual position value is retained.
- If the drive has already been referenced and the position difference is more than the outer window (p2602), alarm A07489 (reference point offset outside window 2) is output and the status bit r2684.3 (pressure mark outside window 2) set. No offset to the actual position value is undertaken.
- If the drive has already been referenced and the position difference is more than the inner window (p2601) and less than the outer window (p2602), the actual position value is offset.

Note

Flying referencing is not an active operating mode. It is superimposed by an active operating mode.

In contrast to reference point approach, flying referencing can be carried out superimposed by the machine process.

As standard, for flying referencing, measuring probe evaluation is used; when enabled, the measuring probe is selected (p2510) and the edge evaluation (p2511) (in the factory setting, measuring probe 1 is always the measuring probe, flank evaluation in the factory setting is always the 0/1 edge).

Instructions for switching data sets

Using drive data set changeover (DDS), motor data sets (p0186) and encoder data sets (p0187 to p0189) can be switched. The following table shows when the reference bit (r2684.11) or the status of the adjustment with absolute encoders (p2507) is reset.

In the following cases, when a DDS changeover takes place, the current actual position value becomes invalid (p2521 = 0) and the reference point (r2684.11 = 0) is reset.

- The EDS that is effective for the position control changes.
- The encoder assignment changes (p2502).
- The mechanical relationships change (p2503...p2506)

With absolute encoders, the status of the adjustment (p2507) is also reset, if the same absolute encoder is selected for the position control although the mechanical relationships have changed (p2503 ... p2506).

In operating mode, an error message (F07494) is also generated.

The following table contains a few examples for data set switching. The initial data set is always DDS0.

9.4 Extended functions

Table 9- 11 DDS switch without load gear position tracking

DDS	p186 (MDS)	p187 (encoder_1)	p188 (encoder_2)	p189 (encoder_3)	Encoder for position control p2502	Mechan. relationships p2504/ p2505/ p2506 or p2503	Load gear position tracking	Changeover response
0	0	EDS0	EDS1	EDS2	encoder_1	xxx	disabled	---
1	0	EDS0	EDS1	EDS2	encoder_1	xxx	disabled	Switching during pulse inhibit or operation has no effect
2	0	EDS0	EDS1	EDS2	encoder_1	yyy	disabled	Pulse inhibit: Position actual value preprocessing is newly initiated ¹⁾ and reference bit ²⁾ is reset. Operation: Error message is generated. Position actual value preprocessing is newly initiated ¹⁾ and reference bit ²⁾ is reset.
3	0	EDS0	EDS1	EDS2	encoder_2	xxx	disabled	Pulse inhibit: Position actual value preprocessing is newly initiated ¹⁾ and reference bit ³⁾ is reset. Operation: Error message is generated. Actual position value conditioning newly set ¹⁾ and reference bit ³⁾ is reset.
4	0	EDS0	EDS3	EDS2	encoder_2	xxx	disabled	
5	1	EDS4	EDS1	EDS2	encoder_1	xxx	disabled	
6	2	EDS5	EDS6	EDS7	encoder_1	zzz	disabled	Operation: Error message is generated. Actual position value conditioning newly set ¹⁾ and reference bit ³⁾ is reset.
7	3	EDS0	EDS1	EDS2	encoder_1	xxx	disabled	MDS switching alone during pulse inhibit or operation has no effect

¹⁾ Is newly initiated means: For absolute encoders, the absolute value is newly read out, and for incremental encoders, a restart will take place as after POWER ON.

²⁾ For incremental encoders, r2684.11 (reference point set) is reset, and for absolute encoders, the status of the adjustment (p2507) is reset as well.

³⁾ For incremental encoders, r2684.11 (reference point set) is reset, and for absolute encoders, the adjustment status (p2507) is not reset because the EDS differs from the original one.

xxx, yyy, zzz: different mechanical conditions

Function diagram

FP 3612	Referencing
FP 3614	Flying referencing

Parameter

- p2596 BI: EPOS set reference point
- p2597 BI: EPOS referencing type selection
- p2598 CI: EPOS reference point coordinates signal source
- p2599 CO: EPOS reference point coordinates value
- p2600 EPOS reference point approach, reference point offset

9.4.6.4 Traversing blocks

Description

Up to 64 different traversing blocks can be saved. The maximum number is set using parameter p2615 (maximum number of traversing blocks).

All parameters which describe a traversing order are effective during a block change, i.e. if:

- the corresponding block number is selected using binector inputs p2625 to p2630 (block selection bits 0...5) and is started using the signal at binector input p2531 (activate traversing block).
- A block change is made in a sequence of traversing tasks.
- An external block change p2632 (external block change) is triggered.

Traversing blocks are parameterized using parameter sets that have a fixed structure:

- Traversing block number (p2616[0...63])

A job number (in STARTER "No.") must be assigned to each traversing block. The traversing blocks are processed in the sequence of the job numbers. Numbers containing the job number "-1" are ignored, which means that the space can be reserved for subsequent traversing blocks, for example.

Task (p2621[0...63])

- 1: POSITIONING
- 2: FIXED ENDSTOP
- 3: ENDLESS_POS
- 4: ENDLESS_NEG
- 5: WAIT
- 6: GOTO
- 7: SET_O
- 8: RESET_O
- 9: JERK

- Motion parameters
 - Target position or traversing distance (p2617[0...63])
 - Velocity (p2618[0...63])
 - Acceleration override (p2619[0...63])
 - Deceleration override (p2620[0...63])

- Task mode (p2623[0...63])

Processing a traversing block can be influenced by means of parameter p2623 (task mode). This is described automatically by programming the traversing blocks in STARTER.

Value = 0000 cccc bbbb aaaa

aaaa: Display / hide

0000: Block is not hidden

0001: Block is hidden

A hidden block cannot be selected binary-coded via binector inputs p2625 to p2630. An alarm is output if you attempt to do so.

bbbb: Continuation condition

0000, END: 0/1 edge at p2631

0001, CONTINUE_WITH_STOP: The position parameterized in the block is approached accurately (brake to standstill and positioning window monitoring) before block processing is continued.

0010, CONTINUE_ON-THE-FLY: An on-the-fly change is made to the next traversing block once the brake usage point of the current block is reached (if a change in direction is required, the change only takes place during a stop in the positioning window)

0011, CONTINUE_EXTERNAL: Behavior such as CONTINUE_ON-THE-FLY; however, an immediate block change can be triggered by a 0/1 edge, up to the braking point. The 0/1 edge can be connected to parameter r2526.2 of the "position control" function module, via the binector input p2633 with p2632 = 1, or via the measuring input p2661 with p2632 = 0. Position detection via the measuring input can be used as an accurate starting position for relative positioning. If no external block change is triggered, a block change occurs at the braking point.

0100, CONTINUE_EXTERNAL_WAIT:	An on-the-fly change can be triggered in the next request during the entire motion phase via the control signal "External block change". If "External block change" is not triggered, the axis remains in the parameterized target position until the signal is issued. CONTINUE_EXTERNAL differs in that an on-the-fly change is executed at the braking point if no "External block change" was triggered, while there is a wait for the signal here in the target position.
0101, CONTINUE_EXTERNAL_ALARM:	The behavior is the same as for CONTINUE_EXTERNAL_WAIT, but alarm A07463 "External traversing block change in traversing block x not requested" is output if an "external block change" has not been triggered before standstill is reached. The alarm can be converted to a fault with a stop response so that block processing can be aborted if the control signal is not issued.

cccc: Positioning mode

With the POSITION task (p2621 = 1), this defines how the position specified in the traversing block is to be approached.

0000, ABSOLUTE:	The position specified in p2617 is approached
0001, RELATIVE:	The axis is traveled along by the value in p2617.
0010, ABS_POS:	Only for rotary axes with modulo offset! The position specified in p2617 is approached in a positive direction.
0011, ABS_NEG:	Only for rotary axes with modulo offset! The position specified in p2617 is approached in a negative direction.

- Task parameter (command-dependent significance) (p2622[0...63])

Intermediate stop and canceling traversing block

The intermediate stop is activated by a 0 signal at p2640. After activation, the system brakes with the parameterized deceleration value (p2620 or p2645).

The current traversing task can be canceled by a 0 signal at p2641. After activation, the system brakes with the maximum deceleration (p2573).

The "intermediate stop" and "cancel traversing task" functions are only effective in the modes "traversing blocks" and "direct setpoint input/MDI".

POSITIONING

The POSITIONING task initiates motion. The following parameters are evaluated:

- p2616[x]: Traversing block number
- p2617[x]: position
- p2618[x]: Velocity
- p2619[x]: Acceleration override
- p2620[x]: Deceleration override
- p2623[x]: Task mode

The task is executed until the target position is reached. If, when the task is activated, the drive is already located at the target position, then for the block change enable (CONTINUE_ON-THE-FLY or CONTINUE_EXTERNAL, the text task is selected in the same interpolation clock cycle. For CONTINUE_WITH_STOP, the next block is activated in the next interpolation clock cycle. CONTINUE_EXTERNAL_ALARM causes a message to be output immediately.

FIXED STOP

The FIXED STOP task triggers a traversing movement with reduced torque to fixed stop.

The following parameters are relevant:

- p2616[x]: Traversing block number
- p2617[x]: position
- p2618[x]: Velocity
- p2619[x]: Acceleration override
- p2620[x]: Deceleration override
- p2623[x]: Task mode
- p2622[x]: Clamping torque in Nm task parameter with rotary motors.

Possible continuation conditions include END, CONTINUE_WITH_STOP, CONTINUE_EXTERNAL, CONTINUE_EXTERNAL_WAIT.

ENDLESS POS, ENDLESS NEG

Using these tasks, the axis is accelerated to the specified velocity and is moved, until:

- a software limit switch is reached.
- A STOP cam signal has been issued.
- The traversing range limit is reached.
- Motion is interrupted by the control signal "no intermediate stop/intermediate stop (p2640).
- Motion is interrupted by the control signal "do not reject traversing task/reject traversing task" (p2641).
- An external block change is triggered (with the appropriate continuation condition).

The following parameters are relevant:

- p2616[x]: Traversing block number
- p2618[x]: Velocity
- p2619[x]: Acceleration override
- p2623[x]: Task mode

All continuation conditions are possible.

JERK

Jerk limitation can be activated (command parameter = 1) or deactivated (task parameter = 0) by means of the JERK task. The signal at the binector input p2575 "Active jerk limitation" must be set to zero. The value parameterized in "jerk limit" (p2574) is the jerk limit.

A precise stop is always carried out here regardless of the parameterized continuation condition of the task preceding the JERK task.

The following parameters are relevant:

- p2616[x]: Traversing block number
- p2622[x]: Task parameter = 0 or 1

All continuation conditions are possible.

WAITING

The WAIT task can be used to define a waiting period which should expire before the next task is executed.

The following parameters are relevant:

- p2616[x]: Traversing block number
- p2622[x]: Task parameter = delay time in milliseconds ≥ 0 ms
- p2623[x]: Task mode

The delay time is entered in milliseconds - but is rounded-off to a multiple of the interpolator clock cycles p0115[5]. The minimum delay time is one interpolation clock cycle; this means that if a delay time is parameterized, which is less than an interpolation clock cycle, then the system waits for one interpolation clock cycle.

Example:

- Delay time: 9 ms
- Interpolation cycle: 4 ms
- Effective delay time: 12 ms

Regardless of the parameterized continuation condition of the task preceding the WAIT task, a precise stop is always carried out here before the delay time. The WAIT task can be executed by an external block change.

Possible continuation conditions include END, CONTINUE_WITH_STOP, CONTINUE_EXTERNAL, CONTINUE_EXTERNAL_WAIT, and CONTINUE_EXTERNAL_ALARM. The alarm or fault is triggered when "External block change" has still not been issued after the delay time has elapsed.

GOTO

Using the GOTO task, jumps can be executed within a sequence of traversing tasks. The block number which is to be jumped to must be specified as task parameter. No continuation conditions are permitted. If there is a block with this number, then alarm A07468 (jump destination does not exist in traversing block x) is output and the block is designated as being inconsistent.

The following parameters are relevant:

- p2616[x]: Traversing block number
- p2622[x]: Task parameter = next task number

Any two of the tasks SET_O, RESET_O and GOTO can be processed in an interpolation cycle and a subsequent POSITION and WAIT task can be started.

SET_O, RESET_O

Tasks SET_O and RESET_O allow up to two binary signals (output 1 or 2) to be simultaneously set or reset. The number of the output (1 or 2) is specified bit-coded in the task parameter.

The following parameters are relevant:

- p2616[x]: Traversing block number
- p2622[x]: Task parameter = output (bit encoded):
 - 0x1: Output 1
 - 0x2: Output 2
 - 0x3: Output 1 + 2

Possible continuation conditions are END, CONTINUE_ON-THE-FLY and CONTINUE_WITH_STOP, and CONTINUE_EXTERNAL_WAIT.

The binary signals (r2683.10 (output 1) (or r2683.11 (output 2)) can be assigned to digital outputs. The assignment in STARTER is made using the button "configuration digital output".

Any two of the SET_O, RESET_O and GOTO orders can be processed in an interpolation cycle and a subsequent POSITION and WAIT order can be started.

Function diagram

FP 3616 Traversing blocks operating mode

Parameter

- p2616 EPOS traversing block, block number
- p2617 EPOS traversing block, position
- p2618 EPOS traversing block, velocity
- p2619 EPOS traversing block, acceleration override
- p2620 EPOS traversing block, delay override
- p2621 EPOS traversing block, order
- p2622 EPOS traversing block, order parameter
- p2623 EPOS traversing block, order mode
- p2625 BI: EPOS block selection, bit 0
- p2626 BI: EPOS block selection, bit 1
- p2627 BI: EPOS block selection, bit 2
- p2628 BI: EPOS block selection, bit 3
- p2629 BI: EPOS block selection, bit 4
- p2630 BI: EPOS block selection, bit 5

9.4.6.5 Traversing to fixed stop**Description**

The "Travel to fixed stop" function can be used, for example, to traverse sleeves to a fixed stop against the workpiece with a predefined torque. In this way, the workpiece can be securely clamped. The clamping torque can be parameterized in the traversing task (p2622). An adjustable monitoring window for travel to fixed stop prevents the drive from traveling beyond the window if the fixed stop should break away.

In positioning mode, traversing to a fixed stop is started when a traversing block is processed with the FIXED STOP command. In this traversing block, in addition to the specification of the dynamic parameterized position, speed, acceleration override and delay override, the required clamping torque can be specified as task parameter p2622. From the start position onwards, the target position is approached with the parameterized speed. The fixed stop (the workpiece) must be between the start position and the braking point of the axis; that is, the target position is placed inside the workpiece. The preset torque limit is effective from the start, i.e. traversing to fixed stop also occurs with a reduced torque. The preset acceleration and delay overrides and the current speed override are also effective. Dynamic following error monitoring (p2546) in the position controller is not effective when traveling to the fixed stop. As long as the drive travels to the fixed stop or is in fixed stop, the "Travel to fixed stop active" status bit r2683.14 is set.

Fixed stop reached

As soon as the axis comes into contact with the mechanical fixed stop, the closedloop control in the drive raises the torque so that the axis can move on. The torque increases up to the value specified in the task and then remains constant. Depending on the binector input p2637 (fixed stop reached), the "fixed stop reached" status bit r2683.12 is set if:

- the following error exceeds the value set in parameter p2634 (fixed stop: maximum following error) (p2637 = r2526.4)
- external status via the signal at binector input p2637 (fixed stop reached), if this p2637 ≠ r2526.4

For traversing to fixed stop, the clamping torque in the traversing block is configured via the task parameter. This is specified in units of 0.01 Nm. The function module is coupled to the torque limit of the basic system via the connector output r2686[0] (torque limit upper) or r2686[1] (torque limit lower), which are connected to the connector input p1528 (torque limit upper scaling) or p1529 (torque limit lower scaling). The connector outputs r2686[0] (torque limit upper) and r2686[1] (torque limit lower) are not set to 100 % during active fixed stop. During an active fixed stop, r2686[0] (upper torque limit) or r2686[1] (lower torque limit) are evaluated as p1522/p1523 in such a way that a limitation to the predefined clamping torque is applied.

When the fixed stop is acknowledged (p2637), the "Speed setpoint total" (p2562) is recorded, as long as the binector input p2553 (fixed stop reached message) is set. The speed control holds the target torque on the basis of the available speed setpoint. The target torque is output for diagnosis via the connector output r2687 (torque setpoint).

In the fixed stop, if the parameterized clamping torque has been reached, the status bit r2683.13 "fixed stop clamping torque reached" is set.

Once the "fixed stop reached" status has been detected, the traversing task "traverse to fixed stop" is ended. Block relaying is carried out in accordance with the parameterization. The drive remains in fixed stop until the next positioning task is processed or the system is switched to jog mode. The clamping torque is therefore also applied during subsequent waiting tasks. The continuation condition CONTINUE_EXTERNAL_WAIT can be used to specify that the drive should remain in fixed stop until an external signal is given for progression.

As long as the drive remains in fixed stop, the position setpoint is adjusted to the actual position value (position setpoint = actual position value). Fixed stop monitoring and controller enable are active.

Note

If the drive is in fixed stop, it can be referenced using the control signal "set reference point."

If the axis moves away from the position that it had at detection of the fixed stop by more than the selected monitoring window for the fixed stop (p2635), then the status bit r2683.12 is reset. At the same time, the speed setpoint is set to zero, and fault F07484 "fixed stop outside of the monitoring window" is triggered with the reaction OFF3 (quick stop). The monitoring window can be set using parameter p2635 (Fixed stop monitoring window). It applies to both positive and negative traversing directions and must be selected in such a way that only a breaking away causes the alarm to be triggered.

Fixed stop is not reached

If the braking point is reached without the "fixed stop reached" status being acknowledged, then the fault F07485 "Fixed stop is not reached" is output with fault reaction OFF1, the torque limit is cancelled and the drive cancels the traversing block.

Note

The fault can be changed into a warning (see chapter: "Message configuration" in the Commissioning Manual IH1), so that the drive continues processing with the specified block relaying.

The target point must be sufficiently far inside the workpiece.

Abort

The "traverse to fixed stop" traversing task can be interrupted and continued using the "intermediate stop" signal at the binector input p2640. The block is cancelled using the binector input signal p2641 "Reject traversing task" or by removing the controller enable. In all of these cases, the drive is correspondingly braked. When canceling occurs, it is ensured that an almost-achieved fixed stop (setpoint already beyond the fixed stop, but still within the threshold for fixed stop detection) will not result in damage. To do this, the setpoint is updated after the standstill (position setpoint = actual position value). As soon as the fixed stop is reached, the drive remains in fixed stop even after cancellation. It can be moved on from the fixed stop using jogging or by selecting a new traversing task.

Note

The fixed stop monitoring window (p2635) is only activated when the drive is in fixed stop and remains active until the fixed stop is exited.

Vertical axes

With asymmetrical torque limits p1522 and p1523, when traversing to fixed stop, the fixed weight is taken into account in the parameters r2686 and r2687.

If, for example, with a suspended load, the values of p1522 = +1000 Nm and of p1523 = -200 Nm are specified, then a fixed weight of 400 Nm (p1522 - p1523) is assumed. If the clamping torque is now configured as 400 Nm, then, during active traversing to fixed stop, r2686[0] is set with the value 80 % and r2686[1] with the value 0 % and r2687 with the value 800 Nm.

Function diagram

FP 3616	Traversing blocks mode (r0108.4 = 1)
FP 3617	Traversing to fixed stop (r0108.4 = 1)
FP 4025	Dynamic following error monitoring, cam controllers (r0108.3 = 1)

Parameter

- p1528 CI: Torque limit, upper/motoring, scaling
- p1529 CI: Torque limit, lower/regenerative scaling
- p1545 BI: Activates travel to fixed stop
- r2526 CO/BO: LR status word
- p2622 EPOS traversing block, order parameter
- p2634 EPOS Fixed stop maximum permissible following error
- p2635 EPOS Fixed stop monitoring window
- p2637 BI: EPOS Fixed stop reached
- p2638 BI: EPOS Fixed stop outside monitoring window
- r2683 CO/BO: EPOS status word 1
- r2686 CO: EPOS Torque limit effective

9.4.6.6 Direct setpoint specification (MDI)

Description

The direct setpoint input function allows for positioning (absolute, relative) and setup (endless position-controlled) by means of direct setpoint input (e.g. via the PLC using process data).

During traversing, the motion parameters can also be influenced (on-the-fly setpoint acceptance) and an on-the-fly change can be undertaken between the Setup and Positioning modes.

The direct setpoint specification operating mode (MDI) can also be used in positioning or setup mode if the axis is not homed. This means that on-the-fly synchronization and re-homing can be carried out with "flying referencing" (see separate section).

The direct setpoint input function is activated by p2647 = 1. A distinction is made between two modes: positioning mode (p2653 = 0) and setup mode (p2653 = 1).

In "positioning" mode, the parameters (position, velocity, acceleration and deceleration) can be used to carry out absolute (p2648 = 1) or relative (p2648 = 0) positioning with the parameter p2690 (fixed setpoint position).

In the setting-up mode, using parameters (velocity, acceleration and deceleration) "endless" closed-loop position control behavior can be carried-out.

It is possible to make a flying changeover between the two modes.

If continuous acceptance (p2649 = 1) is activated, changes to the MDI parameters are accepted immediately. Otherwise the values are only accepted when there is a positive edge at binector input p2650 (setpoint acceptance edge).

Note

Continuous acceptance p2649 = 1 can only be set with free telegram configuration p0922 = 999. No relative positioning is allowed with continuous acceptance.

The direction of positioning can be specified using p2651 (positive direction specification) and p2652 (negative direction specification). If both inputs have the same status, the shortest distance is traveled during absolute positioning (p2648 = "1") of modulo axes (p2577 = "1").

To use the positioning function, the drive must be in operating mode (r0002 = 0). The following options are available for starting positioning:

- p2649 is "1" and positive edge on p2647
- p2649 is "0" and p2647 is "1"
 - positive edge on p2650 or
 - positive edge on p2649

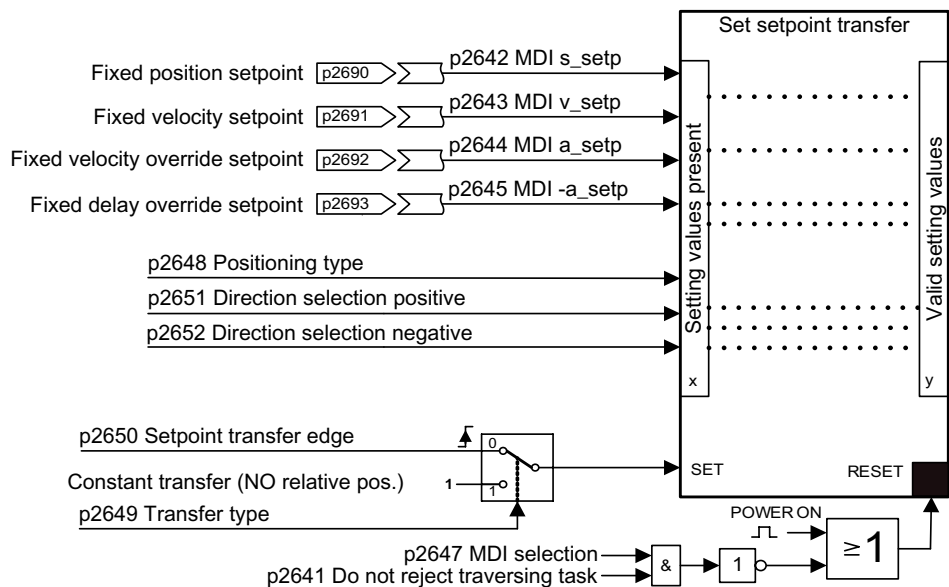


Figure 9-26 Setpoint transfer

MDI mode with the use of PROFIdrive telegram 110.

If connector input p2654 is preset with a connector input $\neq 0$ (e.g. with PROFIdrive telegram 110 with r2059[11]), then it will internally manage the control signals "Positioning type selection", "Positive direction selection" and "Negative direction selection". The following characteristics are evaluated from the value of the connector input:

- xx0x = absolute -> p2648
- xx1x = relative -> p2648
- xx2x = ABS_POS -> p2648, p2651
- xx3x = ABS_NEG -> p2648, p2652

Intermediate stop and canceling traversing block

The intermediate stop is activated by a 0 signal at p2640. After activation, the system brakes with the parameterized deceleration value (p2620 or p2645).

The current traversing task can be canceled by a 0 signal at p2641. After activation, the system brakes with the maximum deceleration (p2573).

The "intermediate stop" and "cancel traversing task" functions are only effective in the modes "traversing blocks" and "direct setpoint input/MDI".

Function diagram

FD 3618	EPOS - direct setpoint specification mode/MDI, dynamic values
FD 3620	EPOS - direct setpoint specification mode/MDI

Parameter

- p2577 BI: EPOS modulo offset activation
- p2642 CI: EPOS direct setpoint input/MDI, position setpoint
- p2643 CI: EPOS direct setpoint input/MDI, velocity setpoint
- p2644 CI: EPOS direct setpoint input/MDI, acceleration override
- p2645 CI: EPOS direct setpoint input/MDI, delay override
- p2648 BI: EPOS direct setpoint input/MDI, positioning type
- p2649 BI: EPOS direct setpoint input/MDI, acceptance type
- p2650 BI: EPOS direct setpoint input/MDI, setpoint acceptance edge
- p2651 BI: EPOS direct setpoint input/MDI, positive direction selection
- p2652 BI: EPOS direct setpoint input/MDI, negative direction selection
- p2653 BI: EPOS direct setpoint input/MDI, setup selection
- p2654 CI: EPOS direct setpoint input/MDI, mode adaptation
- p2690 CO: EPOS position, fixed setpoint
- p2691 CO: EPOS velocity, fixed setpoint
- p2692 CO: EPOS acceleration override, fixed setpoint
- p2693 CO: EPOS delay override, fixed setpoint

9.4.6.7 Jog

Description

Parameter p2591 can be used to switch between "Incremental jog" and "Jog velocity".

Jog signals p2589 and p2590 are used to specify the travel distances p2587 and/or p2588 and the velocities p2585 and p2586. The travel distances are only effective when the "1" signal is at p2591 (incremental jog). When p2591 = "0", the travel range start or the travel range end is approached at the specified velocity.

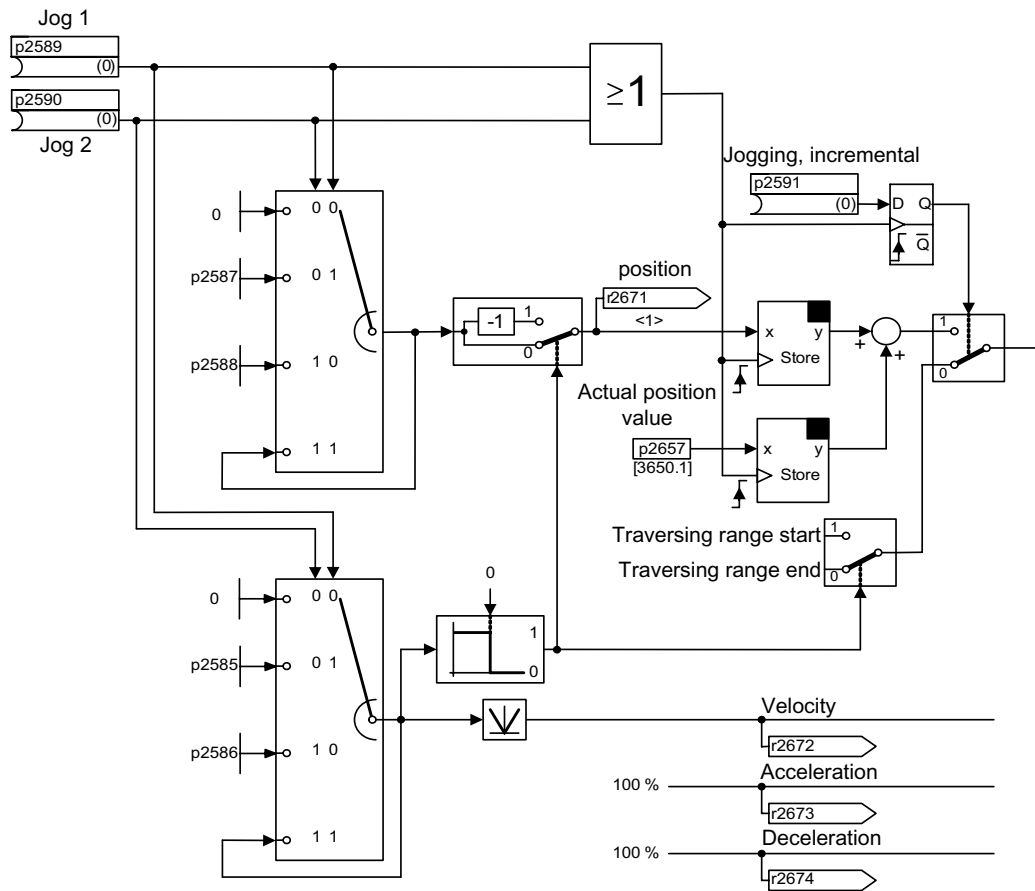


Figure 9-27 Jog mode

Function diagram

FD 3610 EPOS jog mode

Parameters

- p2585 EPOS inching 1 setpoint velocity
- p2586 EPOS inching 2 setpoint velocity
- p2587 EPOS inching 1 travel distance
- p2588 EPOS inching 2 travel distance
- p2589 BI: EPOS inching 1 signal source
- p2590 BI: EPOS inching 2 signal source
- p2591 BI: EPOS incremental inching

9.4.6.8 Status signals

The status signals relevant to positioning mode are described below.

Follow-up mode active (r2683.0)

The "Follow-up mode active" status signal indicates that follow-up mode has been activated (via binector input p2655 (follow-up mode) or via a fault). In this status, the position setpoint follows the actual position value, i.e. position setpoint = actual position value.

Setpoint stationary (r2683.2)

The "Setpoint stationary" status signal indicates that the setpoint velocity has a value of "0". The actual velocity may deviate from zero due to a following error. A traversing block is being processed while the status signal has the value "0".

Motion command active (r2684.15)

The "Motion command active" status signal indicates that a motion command is active. A motion command covers all of the movements carried out (including jog, setup etc.). In contrast to the "Setpoint stationary" status signal, this status signal remains active when a motion command, for example, has been stopped by a velocity override or intermediate stop.

SW limit switch + approached (r2683.7)

SW limit switch - approached (r2683.6)

These status signals indicate that the parameterized negative (p2578/p2580) or positive (p2579/p2581) traversing range limit has been reached or exceeded. If both status signals are "0", the drive is within the traversing range limits.

Stop cam minus active (r2684.13)

Stop cam plus active (r2684.14)

These status signals indicate that "Stop cam, minus" (p2569) or "Stop cam. plus" (p2570) has been exceeded or not reached. The signals are reset when the cams are left in the direction other than that in which they were approached.

Axis moves forwards (r2683.4)

Axis moves backwards (r2683.5)

Axis accelerates (r2684.4)

Drive decelerates (r2684.5)

Drive stationary (zero speed) (r2199.0)

These status signals indicate the current condition of motion. If the actual absolute speed is less or equal to p2161, then the status signal "drive stationary" is set - otherwise it is deleted. The signals are appropriately set if jog mode, reference point approach or a traversing task is active.

Cam switching signal 1 (r2683.8)

Cam switching signal 2 (r2683.9)

The electronic cam function can be implemented using these signals. Cam switch signal 1 is "0" when the actual position is greater than p2547, otherwise the signal is "1". Cam switch signal 2 is "0" when the actual position is greater than p2548, otherwise the signal is "1". The signal is, therefore, canceled when the drive is beyond the cam switch position. The position controller initiates these signals.

Direct output 1 (r2683.10)

Direct output 2 (r2683.11)

If a digital output is parameterized, the function "direct output 1" or "direct output 2", then it can be set by a corresponding command in the traversing task (SET_O) or reset (RESET_O).

Following error in tolerance (r2684.8)

When the axis is traversed in closed-loop position-controlled mode, the permissible following error is calculated from the current velocity and the selected Kv factor on the basis of a model. Parameter p2546 defines a dynamic following error window that defines the permissible deviation from the calculated value. The status signal indicates as to whether the following error is within the window (status 1).

Target position reached (r2684.10)

The status signal "target position reached" indicates that the drive has reached its target position at the end of a traversing command. This signal is set as soon as the actual drive position is inside the positioning window p2544. The signal is reset when the positioning window is exited.

The status signal is not set, if

- signal level 1 is present at binector input p2554 "Motion command active message".
- signal level 0 is present at binector input p2551 "Setpoint stationary message".

The status signal remains set, until

- signal level 1 is present at binector input p2551 "Setpoint stationary message".

Reference point set (r2684.11)

The signal is set as soon as referencing has been successfully completed. It is reset when reference point approach is started.

Acknowledgement, traversing block activated (r2684.12)

A positive edge is used to acknowledge that a new motion command or setpoint has been accepted in "Traversing blocks" mode (same signal level as for binector input p2631 (activate traversing block)). In the mode "direct setpoint input / MDI for setting-up/positioning" a positive edge is used to acknowledge that a new traversing task or setpoint was transferred (the same signal level as binector input p2650 "edge setpoint transfer", if the transfer type was selected using a signal edge (binector input p2649 "0" signal)).

Velocity limiting active (r2683.1)

If the actual setpoint velocity exceeds the maximum velocity p2571 - taking into account the velocity override - it is limited and the control signal is set.

9.5 Monitoring and protective functions

9.5.1 Protecting power components

Description

SINAMICS power units offer comprehensive functions for protecting power components.

Table 9- 12 General protection for power units

Protection against:	Protective measure	Response
Overcurrent ¹⁾	Monitoring with two thresholds: <ul style="list-style-type: none"> • First threshold exceeded 	A30031, A30032, A30033 Current limiting in phase U has responded. Pulsing in this phase is inhibited for one pulse period. F30017 -> OFF2 is triggered if the threshold is exceeded too often.
	<ul style="list-style-type: none"> • Second threshold exceeded 	F30001 "Overcurrent" -> OFF2
DC link overvoltage ¹⁾	Comparison of DC link voltage with hardware shutdown threshold	F30002 "Overvoltage" -> OFF2
DC link undervoltage ¹⁾	Comparison of DC link voltage with hardware shutdown threshold	F30003 "Undervoltage" -> OFF2
Short-circuit ¹⁾	Second monitoring threshold checked for overcurrent	F30001 "Overcurrent" -> OFF2
	Uce monitoring for IGBT module	F30022 "Monitoring Uce" -> OFF2
Ground fault	Monitoring the sum of all phase currents	After threshold in p0287 is exceeded: F30021 "power unit: Ground fault" -> OFF2 Note: The sum of all phase currents is displayed in r0069[6]. For operation, the value in p0287[1] must be greater than the sum of the phase currents when the insulation is intact.
Line phase-failure detection ¹⁾		F30011 "Line phase-failure in main circuit" -> OFF2

¹⁾ The monitoring thresholds are permanently set in the converter and cannot be changed by the user.

9.5.2 Thermal monitoring and overload responses

Description

The priority of thermal monitoring for power components is to identify critical situations. If alarm thresholds are exceeded, the user can set parameterizable response options that enable continued operation (e.g. with reduced power) and prevent immediate shutdown. The parameterization options, however, only enable intervention below the shutdown thresholds, which cannot be changed by the user.

The following thermal monitoring options are available:

- i^2t monitoring – A07805 – F30005
 i^2t monitoring is used to protect components that have a high thermal time constant compared with semi-conductors. Overload with regard to i^2t is present when the converter load (r0036) is greater than 100% (load in % in relation to rated operation).
- Heatsink temperature – A05000 – F30004
Monitoring of the heat-sink temperature (r0037) of the power semi-conductor (IGBT).
- Chip temperature – A05001 – F30025
Significant temperature differences can occur between the barrier layer of the IGBT and the heatsink. These differences are taken into account and monitored by the chip temperature (r0037).

If an overload occurs with respect to any of these three monitoring functions, an alarm is first output. The alarm threshold p0294 (i^2t monitoring) can be parameterized relative to the shutdown (trip) values.

Example

The factory setting for the alarm threshold for chip temperature monitoring is 15 Kelvin (K), and 5 K for the heat sink and inlet air. This means that the "Overtemperature, overload" alarm is triggered at 15 K or 5 K below the shutdown threshold.

The parameterized responses are induced via p0290 simultaneously when the alarm is output. Possible responses include:

- Reduction in pulse frequency (p0290 = 2, 3)
This is a highly effective method of reducing losses in the power unit, since switching losses account for a high proportion of overall losses. In many applications, a temporary reduction in the pulse frequency can be tolerated to allow the process to continue.
Disadvantage:
As a result of the pulse frequency reduction, the current ripple is increased which can mean that the torque ripple is increased at the motor shaft (for low moments of inertia) and also an increased noise level. Reducing the pulse frequency does not affect the dynamic response of the current control circuit, since the sampling time for the current control circuit remains constant.

- Reducing the output frequency (p0290 = 0, 2)
This variant is recommended when you do not need to reduce the pulse frequency or the pulse frequency has already been set to the lowest level. The load should also have a characteristic similar to a fan, that is, a quadratic torque characteristic with falling speed. Reducing the output frequency has the effect of significantly reducing the converter output current which, in turn, reduces losses in the power unit.
- No reduction (p0290 = 1)
You should choose this option if it is neither possible to reduce the pulse frequency nor reduce the output current. The converter does not change its operating point once an alarm threshold has been overshoot, which means that the drive can be operated until it reaches its shutdown values. Once it reaches its shutdown threshold, the converter switches itself off and the "Overtemperature, overload" fault is output. The time until shutdown, however, is not defined and depends on the degree of overload. To ensure that an alarm can be output earlier or that the user can intervene, if necessary, in the drive process (e.g. reduce load/ambient temperature), only the alarm threshold can be changed.

Function diagram

FP 8014 Thermal monitoring, power unit

Parameter

- r0036 Power Module overload
- r0037 Power Module temperatures
- p0290 Power Module overload response
- p0294 Power Module alarm with i²t overload

9.5.3 Blocking protection

Description

The error message "Motor blocked" is only triggered if the speed of the drive is below the variable speed threshold set in p2175. With vector control, it must also be ensured that the speed controller is at the limit. With V/f control, the current limit must already have been reached. Once the ON delay (p2177) has elapsed, the message "Motor blocked" and fault F7900 are generated.

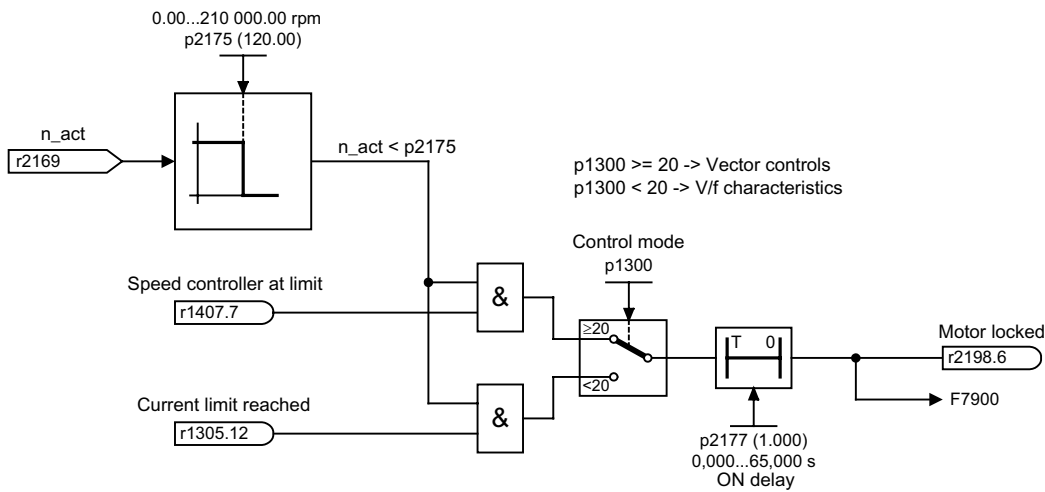


Figure 9-28 Blocking protection

Function diagram

FD 8012 Messages and monitoring - Torque messages, motor blocked/stalled

Parameters

- p2175 Speed threshold motor blocked
- p2177 Delay time motor blocked

9.5.4 Stall protection (only for vector control)

Description

If, for closed-loop speed control with encoder, the speed threshold set in p1744 for stall detection is exceeded, then r1408.11 (speed adaptation, speed deviation) is set.

If the fault threshold value set in p1745 is exceeded when in the low speed range (less than p1755 x p1756), r1408.12 (motor stalled) is set.

If one of the two signals is set, then after the delay time in p2178, fault F7902 (motor stalled) is output.

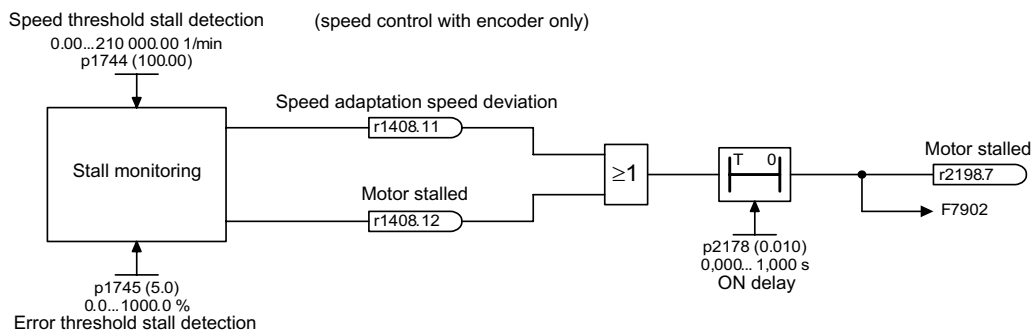


Figure 9-29 Stall protection

Function diagram

FD 6730	Current control
FD 8012	Messages and monitoring - Torque messages, motor blocked/stalled

Parameters

- r1408 CO/BO: Control status word 3
- p1744 Motor model speed threshold stall detection
- p1745 Motor model error threshold stall detection
- p1755 Motor model changeover speed encoderless operation
- p1756 Motor model changeover speed hysteresis
- p2178 Delay time motor stalled

9.5.5 Thermal motor protection

Description

The priority of thermal motor protection is to identify critical situations. If alarm thresholds are exceeded, the user can set parameterizable response options (p0610) that enable continued operation (e.g. with reduced power) and prevent immediate shutdown.

The signal characteristic is shown in diagram 902.

- Effective protection is also possible without a temperature sensor (p4100 = 0). The temperatures of different motor components (stators, core, rotors) can be determined indirectly using a temperature model.
- Connecting temperature sensors (KTY84 or PTC100 to the customer terminal block (TM31) terminal X522:7(+)/8(-)) allows the motor temperature to be determined directly. In this way, accurate start temperatures are available immediately when the motor is switched on again or after a power failure.

Temperature measurement via KTY

The device is connected to terminals X522:7 (anode) and X522:8 (cathode) on the customer terminal block (TM31) in the forward direction of the diode. The measured temperature is limited to between -140 °C and $+248\text{ °C}$ and is made available for further evaluation.

- Set the KTY temperature sensor type: p4100 = 2
- Activate motor temperature measurement via the external sensor: p0600 = 10
In the delivery condition and on completion of commissioning, the source for the external sensor is set to the customer terminal block (TM31) (p0603 = (TM31) r4105).
- When the alarm threshold is reached (set via p0604; factory setting: 120 °C), alarm A7910 is triggered.

Parameter p0610 can be used to set how the drive responds to the alarm triggered:

- 0: No response, only alarm, no reduction of I_max
 - 1: Alarm with reduction of I_max and fault (F7011)
 - 2: Alarm and fault (F7011), no reduction of I_max
- When the fault threshold is reached (set via p0605; factory setting: 155 °C), fault F7011 is triggered in conjunction with the setting in p0610.

Temperature measurement via PTC

The device is connected to terminal X522:7/8 on the customer terminal block (TM31). The threshold for switching to an alarm or fault is 1650 Ω . If the threshold is exceeded, the system switches internally from an artificially-generated temperature value of -50 °C to +250°C and makes it available for further evaluation.

- Set the PTC temperature sensor type: p4100 = 1
- Activate motor temperature measurement via the external sensor: p0600 = 10
In the delivery condition and on completion of commissioning, the source for the external sensor is set to the customer terminal block (TM31) (p0603 = (TM31) r4105).
- Alarm A7910 is triggered once the PTC responds.
- Fault F7011 is triggered once the delay time defined in p0606 has elapsed.

Sensor monitoring for wire breakage/short-circuit

If the temperature of the motor temperature monitor is outside the range -140 °C to +250 °C, the sensor cable is broken or has short-circuited. Alarm A07015 ("Alarm: temperature sensor fault") is triggered. Fault F07016 ("Fault: temperature sensor fault") is triggered once the delay time defined in p0607 has elapsed.

Fault F07016 can be suppressed by p0607 = 0. If an induction motor is connected, the drive continues operating with the data calculated in the thermal motor model.

If the system detects that the motor temperature sensor set in p0600 is not connected, alarm A07820 "Temperature sensor not connected" is triggered.

Function diagram

FP 8016	Thermal monitoring motor
FP 9576	TM31 -temperature evaluation KTY/PTC
FP 9577	TM31 -sensor monitoring KTY/PTC

Parameter

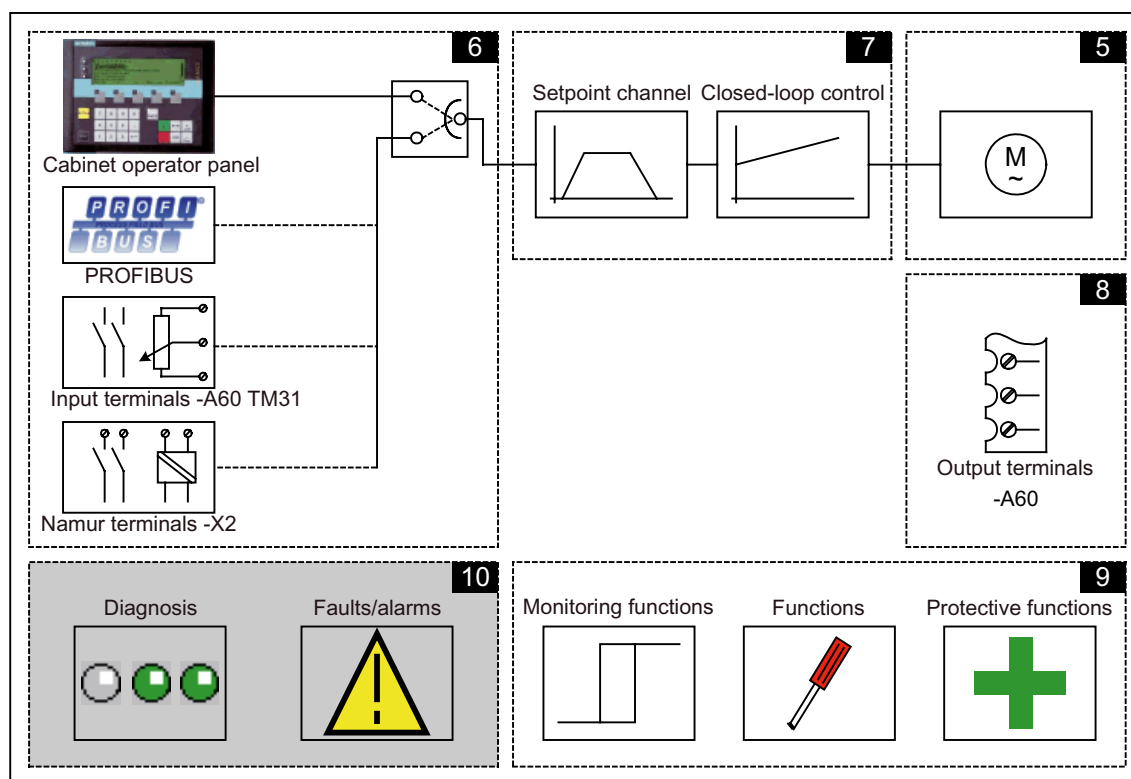
- p0600 Motor temperature sensor for monitoring
- p0604 Motor overtemperature fault threshold
- p0605 Motor overtemperature alarm threshold
- p0606 Motor overtemperature timer
- p0607 Temperature sensor fault timer
- p0610 Response to motor overtemperature condition
- p4100 Temperature evaluation sensor type

Diagnosis / faults and alarms

10.1 Chapter content

This chapter provides information on the following:

- Troubleshooting
- Service and support offered by Siemens AG



10.2 Diagnosis

Description

This section describes procedures for identifying the causes of problems and the measures you need to take to rectify them.

Note

If errors or malfunctions occur in the device, you must carefully check the possible causes and take the necessary steps to rectify them. If you cannot identify the cause of the problem or you discover that components are defective, your regional office or sales office should contact Siemens Service and describe the problem in more detail.

10.2.1 Diagnostics via LEDs

CU320 Control Unit (-A10)

Table 10- 1 Description of the LEDs on the CU320

LED	Color	State	Description
RDY (ready)	---	OFF	The electronics power supply is missing or lies outside permissible tolerance range.
	Green	Steady light	The component is ready for operation and cyclic DRIVE-CLiQ communication is taking place. The Control Unit is awaiting first commissioning.
		2 Hz flashing light	Writing to CompactFlash card.
	Red	Steady light	At least one fault is present in this component.
		0.5 Hz flashing light	CompactFlash card has not been inserted. Boot error (e.g., firmware cannot be loaded to the RAM).
	Green / red	0.5 Hz flashing light	Control Unit 320 is ready for operation. However, there are no software licenses.
	Orange	Steady light	System is booting and DRIVE-CLiQ communication is being established.
		0.5 Hz flashing light	DRIVE-CLiQ component firmware update in progress.
		2 Hz flashing light	Component firmware update complete. Waiting for POWER ON of relevant components.

LED	Color	State	Description
DP1 (PROFIdrive cyclic transmission)	---	OFF	Cyclic communication is not (yet) running. Note: The PROFIdrive is ready for communication when the Control Unit is ready for operation (see RDY LED).
	Green	Steady light	Cyclic communication is running.
		0.5 Hz flashing light	Cyclic communication is not yet fully underway. Possible causes: - The controller is not transmitting any setpoints. - In isochronous mode, the controller did not send a Global Control or it sent a defective Global Control (GC).
	Red	Steady light	Cyclic communication has been interrupted.
	Orange	2 Hz flashing light	Firmware checksum error (CRC error).
OPT (option)	---	OFF	Electronic power supply outside permissible tolerance range. The component is not ready for operation. The Option Board is missing or an associated drive object has not been created.
	Green	Steady light	Option Board is ready.
		0.5 Hz flashing light	Depends on the Option Board used.
	Red	Steady light	At least one fault is pending on this component. The Option Board is not ready (e.g., after switching on).
MOD	---	OFF	Reserved

Customer Terminal Block TM31 (-A60)

Table 10- 2 Description of the LEDs on the TM31

LED	Color	State	Description
RDY	---	OFF	The electronics power supply is missing or lies outside permissible tolerance range.
	Green	Steady light	The component is ready for operation and cyclic DRIVE-CLiQ communication is taking place.
	Orange	Steady light	DRIVE-CLiQ communication is being established.
	Red	Steady light	At least one fault is pending on this component. Note: LED is driven irrespective of the corresponding messages being reconfigured.
	Green / red	0.5 Hz flashing light	Firmware is being downloaded.
		2 Hz flashing light	Firmware download is complete. Waiting for POWER ON.
	Green orange or red orange	2 Hz flashing light	Detection of the components via LED is activated (p0154). Note: Both options depend on the LED status when module recognition is activated via p0154 = 1.

Control Interface Board – Interface module in the Power Module (-T1)

Table 10- 3 Description of the LEDs on the Control Interface Board

LED state		Description
H200	H201	
OFF	OFF	The electronics power supply is missing or lies outside the permissible tolerance range.
Green	OFF	The component is ready for operation and cyclic DRIVE-CLiQ communication is taking place.
	Orange	The component is ready for operation and cyclic DRIVE-CLiQ communication is taking place. The DC link voltage is present.
	Red	The component is ready for operation and cyclic DRIVE-CLiQ communication is taking place. The DC link voltage is too high.
Orange	Orange	DRIVE-CLiQ communication is being established.
Red	---	At least one fault is pending on this component. Note: LED is driven irrespective of the corresponding messages being reconfigured.
Flashing, 0.5 Hz: Green Red	---	Firmware is being downloaded.
Flashing, 2 Hz: Green Red	---	Firmware download is complete. Waiting for POWER ON.
Flashing, 2 Hz: Green / orange or red / orange	---	Detection of the components via LED is activated (p0124). Note: Both options depend on the LED status when module recognition is activated via p0124 = 1.



<p>⚠ WARNING</p> <p>Hazard DC link voltages may be present at any time regardless of the status of the "H201" LED.</p> <p>The warning information on the components must be carefully observed!</p>
--

Control Interface Board – Interface Module in the Power Module (-G1)

Table 10- 4 Description of the LEDs on the Control Interface Board

LED state		Description
H200	H201	
OFF	OFF	The electronics power supply is missing or lies outside the permissible tolerance range.
Green	OFF	The component is ready for operation and cyclic DRIVE-CLiQ communication is taking place.
	Orange	The component is ready for operation and cyclic DRIVE-CLiQ communication is taking place. The DC link voltage is present.
	Red	The component is ready for operation and cyclic DRIVE-CLiQ communication is taking place. The DC link voltage is too high.
Orange	Orange	DRIVE-CLiQ communication is being established.
Red	---	At least one fault is pending on this component. Note: LED is driven irrespective of the corresponding messages being reconfigured.
0.5 Hz flashing light: green/red	---	Firmware is being downloaded.
2 Hz flashing light: green/red	---	Firmware download is complete. Wait for POWER ON.
2 Hz flashing light: green/orange or red/orange	---	Detection of the components via LED is activated (p0124). Note: Both options depend on the LED status when module recognition is activated via p0124 = 1.



<p>! WARNING</p> <p>Hazardous DC link voltages may be present at any time regardless of the status of the "H201" LED. The warnings on the components must be observed.</p>

VSM - Interface Module in the Active Interface Module (-A2)

Table 10- 5 Description of the LEDs on the Voltage Sensing Module

LEDs	Color	Status	Description
RDY	---	OFF	The electronics power supply is missing or lies outside the permissible tolerance range.
	Green	Continuous	The component is ready for operation and cyclic DRIVE-CLiQ communication is taking place.
	Orange	Continuous	DRIVE-CLiQ communication is being established.
	Red	Continuous	At least one fault is pending on this component. Note: LED is driven irrespective of the corresponding messages being reconfigured.
	Green/red	0.5 Hz flashing light	Firmware is being downloaded.
		2 Hz flashing light	Firmware download is complete. Wait for POWER ON.
	Green/orange or red/orange	2 Hz flashing light	Detection of the components via LED is activated (p0144). Note: Both options depend on the LED status when module recognition is activated via p0144 = 1.

SMC10 – encoder evaluation (-B81)

Table 10- 6 Description of the LEDs on the SMC10

LED	Color	State	Description
RDY	---	OFF	The electronics power supply is missing or lies outside the permissible tolerance range.
	Green	Steady light	The component is ready for operation and cyclic DRIVE-CLiQ communication is taking place.
	Orange	Steady light	DRIVE-CLiQ communication is being established.
	Red	Steady light	At least one fault is pending on this component. Note: LED is driven irrespective of the corresponding messages being reconfigured.
	Green Red	Flashing, 0.5 Hz	Firmware is being downloaded.
		Flashing, 2 Hz	Firmware download is complete. Waiting for POWER ON.
	Green / orange or red / orange	Flashing, 2 Hz	Detection of the components via LED is activated (p0144). Note: Both options depend on the LED status when module recognition is activated via p0144 = 1.

SMC20 – encoder evaluation (-B82)

Table 10- 7 Description of the LEDs on the SMC20

LED	Color	State	Description	
RDY	---	OFF	The electronics power supply is missing or lies outside the permissible tolerance range.	
	Green	Steady light	The component is ready for operation and cyclic DRIVE-CLiQ communication is taking place.	
	Orange	Steady light	DRIVE-CLiQ communication is being established.	
	Red	Steady light	At least one fault is pending on this component. Note: LED is driven irrespective of the corresponding messages being reconfigured.	
	Green Red		Flashing, 0.5 Hz	Firmware is being downloaded.
			Flashing, 2 Hz	Firmware download is complete. Waiting for POWER ON.
	Green / orange or red / orange	Flashing, 2 Hz	Detection of the components via LED is activated (p0144). Note: Both options depend on the LED status when module recognition is activated via p0144 = 1.	

SMC30 – encoder evaluation (-B83)

Table 10- 8 Description of the LEDs on the SMC30

LED	Color	State	Description	
RDY	---	OFF	The electronics power supply is missing or lies outside the permissible tolerance range.	
	Green	Steady light	The component is ready for operation and cyclic DRIVE-CLiQ communication is taking place.	
	Orange	Steady light	DRIVE-CLiQ communication is being established.	
	Red	Steady light	At least one fault is pending on this component. Note: LED is driven irrespective of the corresponding messages being reconfigured.	
	Green Red		Flashing, 0.5 Hz	Firmware is being downloaded.
			Flashing, 2 Hz	Firmware download is complete. Waiting for POWER ON.
	Green / orange or red / orange	Flashing, 2 Hz	Detection of the components via LED is activated (p0144). Note: Both options depend on the LED status when module recognition is activated via p0144 = 1.	
OUT>5 V	---	OFF	Electronics power supply is missing or outside permissible tolerance range. Power supply ≤ 5 V.	
	Orange	Steady light	Electronic power supply for measuring system present. Supply voltage > 5 V. Notice: You must ensure that the connected encoder can be operated with a 24 V supply. Operating an encoder designed for a 5 V supply with a 24 V supply can damage the encoder electronics beyond repair.	

CBE20 – Communication Board Ethernet (option G33)

Table 10- 9 Description of the LEDs on the CBE20

LED	Color	State	Description
Link port	---	OFF	The electronics power supply is missing or lies outside the permissible tolerance range.
	Green	Steady light	A different device is connected to port x and a physical connection exists.
Activity port	---	OFF	The electronics power supply is missing or lies outside the permissible tolerance range.
	Yellow	Steady light	Data is being received or sent at port x.
Fault	---	OFF	If the link port LED is green: The CBE20 is operating normally, data is being exchanged with the configured IO Controller.
	Red	Flashing	<ul style="list-style-type: none"> - The response monitoring time has elapsed. - Communication has been interrupted. - The IP address is incorrect. - Incorrect or missing configuration. - Incorrect parameterization. - Incorrect or missing device name. - IO Controller not present/switched off but Ethernet connection present. - Other CBE20 errors
		Steady light	CBE20 bus fault <ul style="list-style-type: none"> - No physical connection to a subnet/switch. - Incorrect transmission rate. - Full-duplex transmission not activated.
Sync	---	OFF	If the link port LED is green: Control Unit task system is not synchronized with the IRT clock. An internal substitute clock is generated.
	Green	Flashing	Control Unit task system has synchronized with the IRT clock and data is being exchanged.
		Steady light	Task system and MC-PLL have synchronized with the IRT clock.
OPT on the Control Unit	---	OFF	The electronics power supply is missing or lies outside the permissible tolerance range. Communication Board either defective or not inserted.
	Green	Steady light	Communication Board is ready and cyclic communication is taking place.
		Flashing, 0.5 Hz	The Communication Board is ready, but cyclic communication is not yet taking place. Possible causes: <ul style="list-style-type: none"> - At least one fault is pending. - Communication is being established.
	Red	Steady light	Cyclic communication via PROFINET has not yet been established. However, acyclic communication is possible. SINAMICS is waiting for a parameterization/configuration telegram.
		Flashing, 0.5 Hz	The firmware download to the CBE20 has failed. Possible causes: <ul style="list-style-type: none"> - The CBE20 is defective. - The memory card for the Control Unit is defective. In this state, the CBE20 cannot be used.

LED	Color	State	Description
		Flashing, 2.5 Hz	Communication between the Control Unit and the CBE20 is faulty. Possible causes: - The CBE20 was removed following power-up. - The CBE20 is defective.
	Orange	Flashing, 2.5 Hz	Firmware is being downloaded.

10.2.2 Diagnostics via parameters

All Objects: key diagnostic parameters (details in List Manual)

Parameters	Name
	Description
r0945	Fault code
	Displays the fault number. Index 0 is the most recent fault (last fault to have occurred).
r0948	Fault time received in milliseconds
	Displays the system runtime in ms at which the fault occurred.
r0949	Fault value
	Displays additional information about the fault. This information is required for detailed fault diagnosis.
r2109	Fault time removed in milliseconds
	Displays the system runtime in ms at which the fault was rectified.
r2123	Alarm time received in milliseconds
	Displays the system runtime in ms at which the alarm occurred.
r2124	Alarm value
	Displays additional information about the alarm. This information is required for detailed alarm diagnosis.
r2125	Alarm time removed in milliseconds
	Displays the system runtime in ms at which the alarm was rectified.

CU320: key diagnostic parameters (details in List Manual)

Parameters	Name
	Description
r0002	Control Unit status display
	Status display for the Control Unit
r0018	Control Unit firmware version
	Displays the firmware version of the Control Unit. For the display parameters for the firmware version of the other connected components, see the parameter description in the List Manual.
r0721	Digital inputs actual terminal value
	Displays the actual value at the digital input terminals on the CU. This parameter shows the actual value, uninfluenced by simulation mode of the digital inputs.

Parameters	Name
	Description
r0722	Status of digital inputs (CU)
	Displays the status of the digital inputs on the CU. This parameter shows the status of the digital inputs under the influence of simulation mode of the digital inputs.
r0747	Status of digital outputs (CU)
	Display of the CU digital output status. This parameter shows the status of the digital inputs under the influence of simulation mode of the digital inputs.
r2054	Profibus status
	Displays the status of the Profibus interface.
r9976[0..7]	System load
	Displays the system load. The individual values (computation load and cyclic load) are measured over short time slices; from these values, the maximum, the minimum and the average value are generated and displayed in the appropriate indices. Further, the degree of memory utilization of the data and program memory is displayed.

Supply: key diagnostic parameters (details in List Manual)

Parameters	Name
	Description
r0002	Status display
	The value provides information about the current operating status and the conditions necessary to reach the next status.
r0025	Infeed input voltage, smoothed
	Displays the smoothed actual value of the input voltage. This voltage is present at the line supply connection of the infeed voltage.
r0026	DC link voltage smoothed
	Displays the smoothed actual value of the DC link.
r0027	Absolute actual current, smoothed
	Displays the smoothed actual value of the current.
r0037	Power Module temperatures
	Displays the measured temperatures in the Power Module.
r0046	Missing enable signals
	Displays missing enable signals that are preventing the closed-loop infeed control from being commissioned.
r0050	Active command data set (CDS):
	Displays the effective command data set (CDS)
r0206	Rated power module power
	Displays the rated power module power for various load duty cycles.
r0207	Rated power module current
	Displays the rated power module power for various load duty cycles.
r0208	Rated power module line supply voltage
	Displays the rated line supply voltage of the Power Module.

Vector: key diagnostic parameters (details in List Manual)

Parameters	Name
	Description
r0002	Operating display
	The value provides information about the current operating status and the conditions necessary to reach the next status.
r0020	Speed setpoint smoothed
	Displays the actual smoothed speed/velocity setpoint at the input of the speed/velocity controller or V/f characteristic (after the interpolator).
r0021	Actual speed smoothed
	Displays the smoothed actual value of the motor speed/velocity.
r0026	DC link voltage smoothed
	Displays the smoothed actual value of the DC link.
r0027	Absolute actual current smoothed
	Displays the smoothed actual value of the current.
r0031	Actual torque smoothed
	Displays the smoothed actual torque.
r0035	Motor temperature
	If r0035 does not equal -200.0 °C, the following applies:
	<ul style="list-style-type: none"> • This temperature indicator is valid. • An KTY sensor is connected. • If using an asynchronous motor, the thermal motor model is activated (p0600 = 0 or p0601 = 0).
	If r0035 equals -200.0 °C, the following applies:
r0037	Power Module temperatures
	Displays the measured temperatures in the Power Module.
r0046	Missing drive enable signals
	Displays missing enable signals that are preventing the closed-loop drive control from being commissioned.
r0049	Motor/encoder data set effective (MDS, EDS)
	Displays the effective motor data set (MDS) and the effective encoder data sets (EDS).
r0050	Command data set effective (CDS)
	Displays the effective command data set (CDS)
r0051	Drive data set (DDS) effective
	Effective drive data set (DDS) display.
r0206	Rated power module power
	Displays the rated power module power for various load duty cycles.
r0207	Rated power module current
	Displays the rated power module power for various load duty cycles.
r0208	Rated power module line supply voltage
	Displays the rated line supply voltage of the power module.

TM31: key diagnostic parameters (details in List Manual)

Parameters	Name
	Description
r0002	TM31 operating display
	Operating display for terminal board 31 (TB31).
r4021	Digital inputs actual terminal value
	Displays the actual value at the digital input terminals on the TM31. This parameter shows the actual value, uninfluenced by simulation mode of the digital inputs.
r4022	Status of digital inputs
	Displays the status of the digital inputs on the TM31. This parameter shows the status of the digital inputs under the influence of simulation mode of the digital inputs.
r4047	Status of digital outputs
	Displays the status of the TM31 digital outputs. Inversion via p4048 is taken into account.

10.2.3 Indicating and rectifying faults

The device features a wide range of functions that protect the drive against damage if a fault occurs (faults and alarms).

Indicating faults and alarms

If a fault occurs, the drive displays the fault and/or alarm on the AOP30 operator panel. Faults are indicated by the red "FAULT" LED and a fault screen is automatically displayed. You can use the F1 Help function to call up information about the cause of the fault and how to remedy it. You can use F5 Ack. to acknowledge a stored fault.

Any alarms are displayed by the yellow flashing "ALARM" LED. The system also displays a note in the status bar providing information on the cause.

Every fault and alarm is entered in the fault/alarm buffer along with time the error occurred. The time stamp refers to the relative system time in milliseconds (r0969).

Activate the "Set date/time - AOP synchronization -> Drive" setting to date- and time-stamp errors on the AOP30.

What is a fault?

A fault is a message from the drive indicating an error or other exceptional (unwanted) status. This could be caused by a fault within the converter or an external fault triggered, for example, from the winding temperature monitor for the induction motor. The faults are displayed and can be reported to a higher-level control system via PROFIdrive. In the factory default setting, the message "converter fault" is also sent to a relay output. Once you have rectified the cause of the fault, you have to acknowledge the fault message.

What is an alarm?

An alarm is the response to a fault condition identified by the drive. It does not result in the drive being switched off and does not have to be acknowledged. Alarms are "self acknowledging", that is, they are reset automatically when the cause of the alarm has been eliminated.

10.3 Overview of warnings and faults

If a fault occurs, the drive indicates the fault and/or alarm. Faults and alarms are listed in a fault/alarm list, together with the following information:

- Fault/alarm number
- Standard drive response
- Description of the possible cause of the fault/alarm
- Description of the procedure for rectifying the problem
- Standard fault acknowledgement after it has been rectified

Note

The list of faults and alarms is contained on the documentation CD.

It also contains descriptions of the responses (OFF1, OFF2, etc.).

Note

The faults and alarms described below have been wired specially for the cabinet units listed in this document and preset via macro. In this way, the appropriate reaction is triggered by the additional components in the cabinet unit when faults and alarms are signaled.

It is possible to reprogram the faults and alarms described, provided that the stated options are not included in the scope of the equipment.

10.3.1 "External alarm 1"

Causes

Alarm A7850 ("External alarm 1") is triggered by the following optional protection devices in the cabinet unit:

- Thermistor motor protection unit alarm (option L83)
- PT100 Evaluation Unit (Option L86)

Remedy

When a fault is indicated, the following procedure is recommended:

1. Identify the cause by examining the specified devices (display or LEDs).
2. Check the fault display on the relevant protection device and establish the fault.
3. Rectify the displayed fault with the help of the appropriate operating instructions provided in "Additional Operating Instructions".

10.3.2 "External fault 1"

Causes

Fault code F7860 ("External Fault 1") is triggered by the following optional protection devices in the cabinet unit:

- Thermistor motor protection unit shutdown (option L84)
- PT100 Evaluation Unit (Option L86)

Remedy

When a fault is indicated, the following procedure is recommended:

1. Identify the cause by examining the specified devices (display or LEDs).
2. Check the fault display on the relevant protection device and establish the fault.
3. Rectify the displayed fault with the help of the appropriate operating instructions provided in "Additional Operating Instructions".

10.3.3 "External fault 2"

Causes

Fault code F7861 "External Fault 2" is triggered when the braking resistor available with options L61/L62/L64/L65 is subject to thermal overload, thereby activating the thermostat. The drive is switched off with OFF2.

Remedy

The cause of the braking resistor overload must be eliminated and the fault code acknowledged.

10.3.4 "External fault 3"

Causes

Fault code F7862 "External fault 3" is triggered when the braking unit fitted for options L61/L62/L64/L65 triggers a fault. The drive is switched off with OFF2.

Remedy

The cause of the braking unit overload must be eliminated and the fault code acknowledged.

10.4 Service and Support

Service and Support helpline

If you need help and do not know who to contact, we make sure that you receive all the help you need as quickly as possible.

The helpline ensures that a specialist in your area can provide you with professional support. The helpline (in Germany, for example) is available 24 hours a day, 365 days a year. German and English are spoken.

Tel.: 0180 50 50 111

Online Support

Our round-the-clock, worldwide online support service provides quick and efficient support in five languages. The comprehensive Internet-based information system, which is available round the clock, provides product support, services, and support tools in the shop.

Online support provides a wide range of technical information:

- FAQs, tips and tricks, downloads, current news
- Manuals
- Helpful programs and software products
- <http://www.siemens.de/automation/service&support>

Field service

If your plant is down and you need fast, on-site help, we can provide the specialists with the required expertise wherever you are.

With our comprehensive service network, we offer professional and reliable expertise to get your plant up and running again as quickly as possible.

Experts are available 24 hours a day, 365 days a year.

Tel.: 0180 50 50 444

Of course, we can also arrange special service contracts tailored to your specific requirements. For details, please contact your Siemens office.

Spare parts and repairs

Our global network of regional spare parts warehouses and repair centers enables us to respond quickly and reliably with modern logistics procedures.

During the operational phase of your machinery, we provide a comprehensive repairs and spare parts service to ensure maximum operational reliability. Our service includes expert advice with technical problems, and a wide range of product and system support services tailored to your needs.

For more information about repairs or spare parts, please call the following number (in Germany):

Tel.: 0180 50 50 448

You can call this number outside office hours and at the weekend to contact our emergency spare parts service.

Technical support

We offer technical support in both German and English for deploying products, systems, and solutions in drive and automation technology.

In special cases, help is available from professional, trained, and experienced specialists via teleservice and video conferencing.

Free Contact – providing you with free technical support

- In Europe / Africa
Tel.: +49 (0)180 50 50 222
Fax: +49 (0)180 50 50 223
Internet: <http://www.siemens.de/automation/support-request>
- in America
Tel.: +14232622522
Fax: +14232622289
E-mail: simatic.hotline@sea.siemens.com
- Asia / Pacific region
Tel.: +86 1064 757575
Fax: +86 1064 747474
E-mail: adsupport.asia@siemens.com

Note

Calls are subject to charge (e.g. € 0.14/min from fixed lines within Germany). Tariffs of other phone providers may differ.

10.4.1 Spare parts

The spare parts available for the ordered cabinet unit can be found in the spare parts list.

This list is provided on the documentation CD.

Maintenance and servicing

11.1 Chapter content

This chapter provides information on the following:

- Maintenance and servicing procedures that have to be carried out on a regular basis to ensure the availability of the cabinet units.
- Exchanging device components when the unit is serviced
- Forming the DC link capacitors
- Upgrading the cabinet unit firmware
- Loading the new operator panel firmware from the PC.



DANGER

Five safety rules

When carrying out any kind of work on electrical devices, the "five safety rules" must always be observed:

1. Disconnect the system
2. Protect against reconnection.
3. Make sure that the equipment has zero potential
4. Ground and short-circuit.
5. Cover or fence off adjacent components that are still live.



DANGER

Before carrying out any maintenance or repair work on the de-energized cabinet unit, wait for 5 minutes after switching off the supply voltage. This allows the capacitors to discharge to a harmless level (< 25 V) after the supply voltage has been switched off.

Before starting work, you should also measure the voltage after the 5 minutes have elapsed. The voltage can be measured on DC link terminals DCP and DCN.



DANGER

When the external power supply for individual options (L50 / L55) or the external 230 V AC auxiliary supply is connected, dangerous voltages are still present in the cabinet unit even when the main circuit breaker is open.

11.2 Maintenance

The cabinet unit mainly comprises electronic components. Apart from the fan(s), the unit contains very few components that are subject to wear or require maintenance or servicing. Maintenance aims to preserve the specified condition of the cabinet unit. Dirt and contamination must be removed regularly and parts subject to wear replaced.

The following points must generally be observed.

11.2.1 Cleaning

Dust deposits

Dust deposits inside the cabinet unit must be removed at regular intervals (or at least once a year) by qualified personnel in line with the relevant safety regulations. The unit must be cleaned using a brush and vacuum cleaner, and dry compressed air (max. 1 bar) for areas that cannot be easily reached.

Ventilation

The ventilation openings in the cabinet must never be obstructed. The fan must be checked to make sure that it is functioning correctly.

Cable and screw terminals

Cable and screw terminals must be checked regularly to ensure that they are secure in position, and if necessary, retightened. Cabling must be checked for defects. Defective parts must be replaced immediately.

Note

The actual intervals at which maintenance procedures are to be performed depend on the installation conditions (cabinet environment) and the operating conditions.

Siemens offers its customers support in the form of a service contract. For further details, contact your regional office or sales office.

11.3 Maintenance

Servicing involves activities and procedures for maintaining and restoring the specified condition of the device.

Required tools

The following tools are required for replacing components:

- Spanner or socket spanner (w/f 10)
- Spanner or socket spanner (w/f 13)
- Spanner or socket spanner (w/f 16/17)
- Spanner or socket spanner (w/f 18/19)
- Hexagon-socket spanner (size 8)
- Torque wrench up to 50 Nm
- Screwdriver size 1 / 2
- Screwdriver Torx T20
- Screwdriver Torx T30

Tightening torques for current-carrying parts

When securing connections for current-conducting parts (DC link/motor connections, busbars), you must observe the following tightening torques.

Table 11- 1 Tightening torques for connecting current-carrying parts

Screw	Torque
M6	6 Nm
M8	13 Nm
M10	25 Nm
M12	50 Nm

11.3.1 Installation device

Description

The installation device is used for installing and removing the power blocks.

It is used as an installation aid, which is placed in front of and secured to the module. The telescopic guide support allows the withdrawable device to be adjusted according to the height at which the power blocks are installed. Once the mechanical and electrical connections have been removed, the power block can be removed from the module, whereby the power block is guided and supported by the guide rails on the withdrawable devices.



Figure 11-1 Installation device

Order number

Order number for the installation device: 6SL3766-1FA00-0AA0.

11.3.2 Using crane lifting lugs to transport power blocks

Crane lifting lugs

The power blocks are fitted with crane lifting lugs for transportation on a lifting harness in the context of replacement.

The positions of the crane lifting lugs are illustrated by arrows in the figures below.

WARNING

A lifting harness with vertical ropes or chains must be used to prevent any risk of damage to the housing.

CAUTION

The power block busbars must not be used to support or secure lifting harnesses for the purpose of transportation.

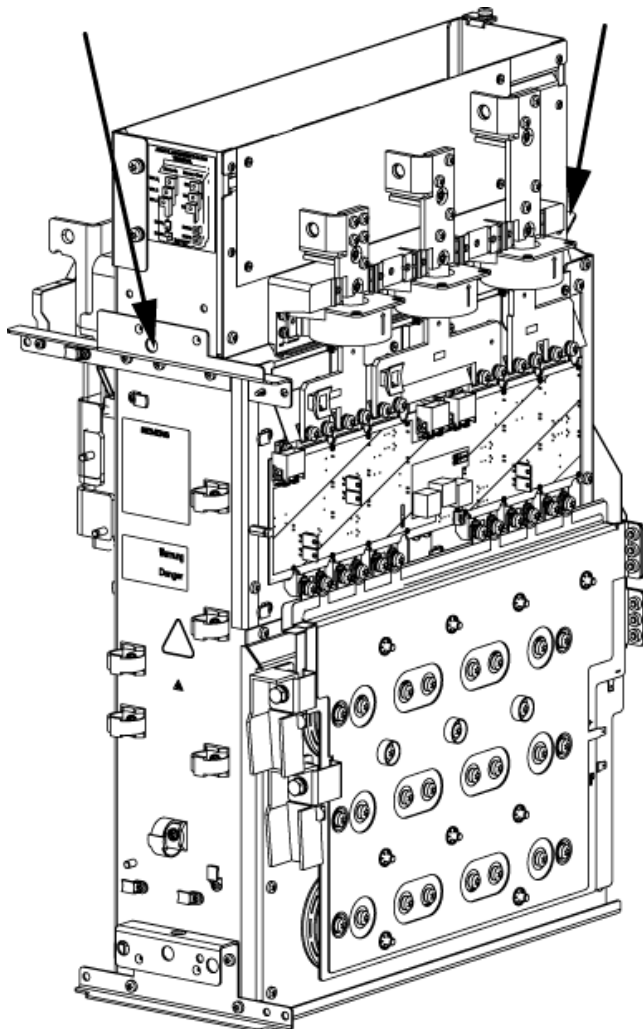


Figure 11-2 Crane lifting lugs on FX, GX power block

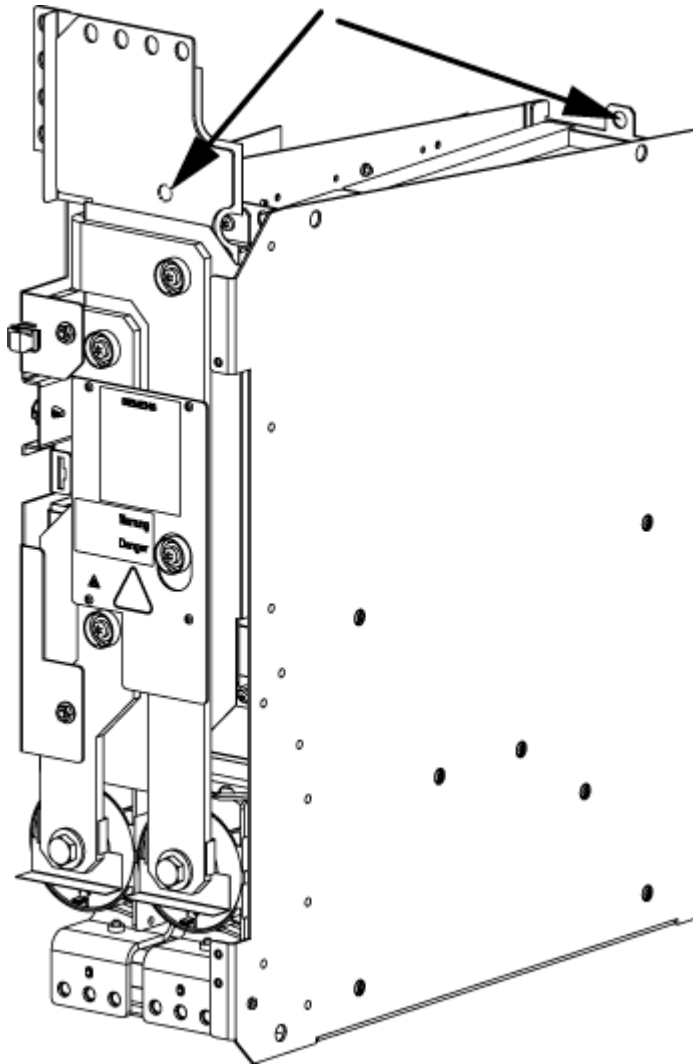



Figure 11-3 Crane lifting lugs on HX, JX power block


Note

On HX and JX power blocks, the front crane lifting lug is located behind the busbar.


11.4 Replacing components

 WARNING
The following must be taken into account when the devices are transported: <ul style="list-style-type: none">• Some of the devices are heavy or top heavy.• Due to their weight, the devices must be handled with care by trained personnel.• Serious injury or even death and substantial material damage can occur if the devices are not lifted or transported properly.



 WARNING
The devices are operated with high voltages. All connection work must be carried out when the cabinet is de-energized! All work on the device must be carried out by trained personnel only. Non-observance of these warnings can result in death, serious personal injury, or substantial property damage. Work on an open device must be carried out with extreme caution because external supply voltages may be present. The power and control terminals may be live even when the motor is not running. Dangerously high voltage levels are still present in the device up to five minutes after it has been disconnected due to the DC link capacitors. For this reason, the unit should not be opened until a reasonable period of time has elapsed.



 DANGER
Five safety rules When carrying out any kind of work on electrical devices, the "five safety rules" must always be observed: <ol style="list-style-type: none">1. Disconnect the system2. Protect against reconnection.3. Make sure that the equipment has zero potential4. Ground and short-circuit.5. Cover or fence off adjacent components that are still live.

11.4.1 Replacing the filter mats

The filter mats must be checked at regular intervals. If the mats are too dirty to allow the air supply to flow normally, they must be replaced.

Note

Filter mat replacement is only relevant for options M23, M43 and M54.

Not replacing contaminated filter mats can cause premature drive shutdown.

11.4.2 Replacing the power block (frame size FX)

Replacing the power block

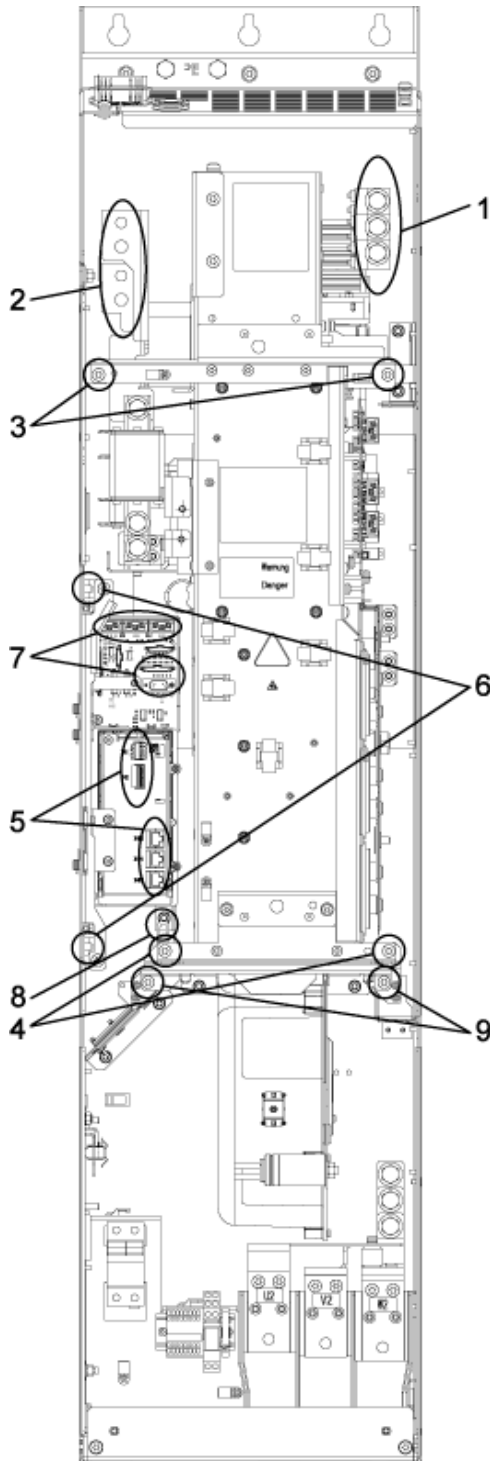


Figure 11-4 Replacing the power block (frame size FX)

Preparatory steps

- Disconnect the cabinet unit from the power supply.
- Allow unimpeded access to the power block.
- Remove the protective cover.

Removal steps

The removal steps are numbered in accordance with the figure.

1. Unscrew the connection to the line or to the motor (3 screws).
2. Unscrew the connection to the DC link (4 screws).
3. Remove the retaining screws at the top (2 screws).
4. Remove the retaining screws at the bottom (2 screws).
5. Remove the DRIVE-CLiQ cables and connections to the CU320 (5 plugs).
6. Remove the CU320 mounts (1 screw and 2 nuts). If necessary, remove the PROFIBUS plug and connection to the operator panel (-X140 on the CU320) and remove the CU320.
7. Disconnect the plug-in connections for the fiber-optic cables and signal cables (5 plugs).
8. Disconnect the plug for the thermocouple.
9. Unscrew the two retaining screws for the fan and attach the tool for de-installing the power block at this position.

You can now remove the power block.

CAUTION

When removing the power block, ensure that you do not damage any signal cables.

Installation steps

For installation, carry out the above steps in reverse order.

CAUTION

The tightening torques specified in the table "Tightening torques for connecting current-conducting parts" must be observed.
--

Carefully establish the plug-in connections and then ensure that they are secure.

The fiber-optic cable plugs must be remounted at their original slot. Fiber-optic cables and sockets are accordingly labeled for correct assignment (U11, U21, U31).
--

The screwed connections for the protective covers must only be tightened by hand.

11.4.3 Replacing the power block (frame size GX)

Replacing the power block

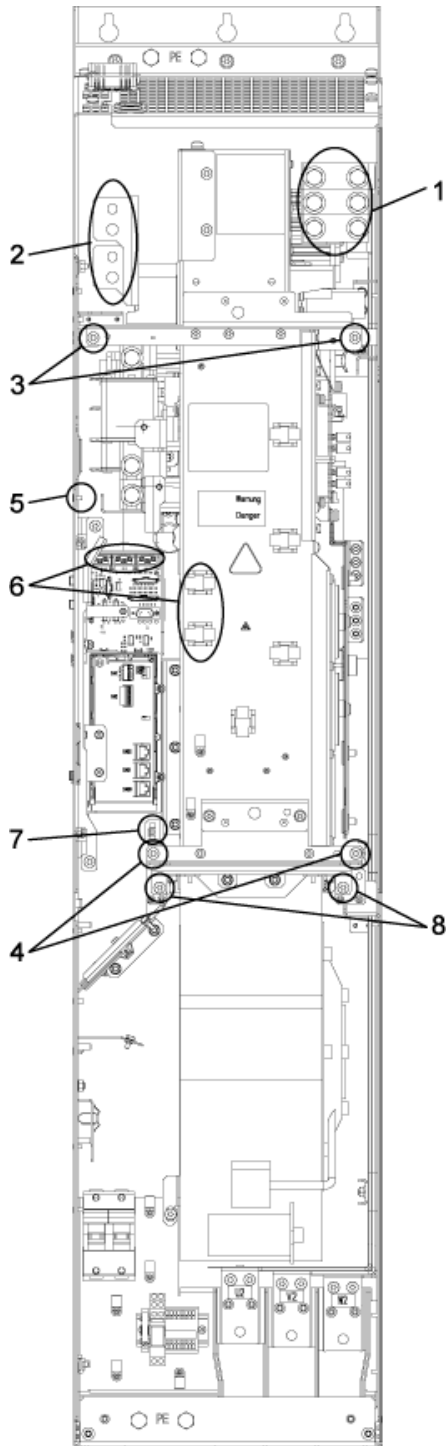


Figure 11-5 Replacing the power block (frame size GX)

Preparatory steps

- Disconnect the cabinet unit from the power supply.
- Allow unimpeded access to the power block.
- Remove the protective cover.

Removal steps

The removal steps are numbered in accordance with the figure.

1. Unscrew the connection to the line or to the motor (3 screws).
2. Unscrew the connection to the DC link (4 screws).
3. Remove the retaining screws at the top (2 screws).
4. Remove the retaining screws at the bottom (2 screws).
5. Remove the CU320 mount (1 nut). If necessary, remove the PROFIBUS plug and connection to the operator panel (-X140 on the CU320) and carefully remove the CU320.
6. Disconnect the connectors for the fiber-optic cables (5 plugs) and release the cable connection for the signal cables (2 connectors).
7. Disconnect the plug for the thermocouple.
8. Unscrew the two retaining screws for the fan and attach the tool for de-installing the power block at this position.

You can now remove the power block.

CAUTION

When removing the power block, ensure that you do not damage any signal cables.

Installation steps

For installation, carry out the above steps in reverse order.

CAUTION

The tightening torques specified in the table "Tightening torques for connecting current-conducting parts" must be observed.
--

Carefully establish the plug-in connections and then ensure that they are secure.

The fiber-optic cable plugs must be remounted at their original slot. Fiber-optic cables and sockets are accordingly labeled for correct assignment (U11, U21, U31).
--

The screwed connections for the protective covers must only be tightened by hand.

11.4.4 Replacing the power block (frame size HX)

Replacing the left-hand power block

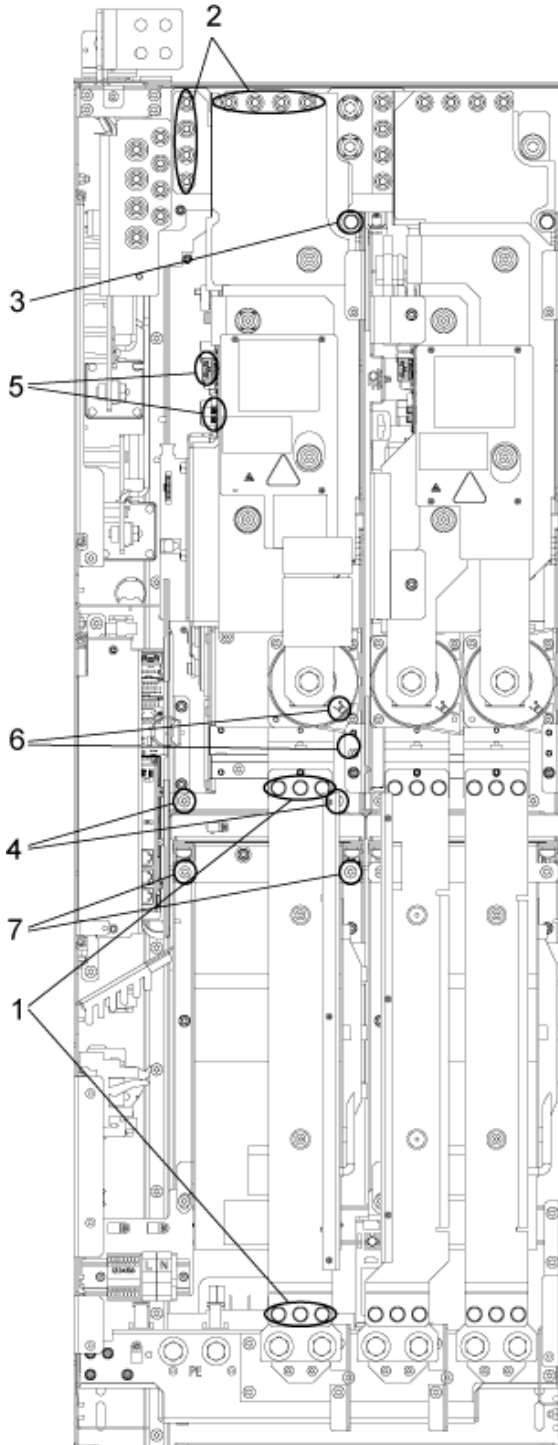


Figure 11-6 Replacing the power block (frame size HX) (left-hand power block)

Preparatory steps

- Disconnect the cabinet unit from the power supply.
- Allow unimpeded access to the power block.
- Remove the protective cover.

Removal steps

The removal steps are numbered in accordance with the figure.

1. Remove the busbar (6 screws).
2. Unscrew the connection to the DC link (8 nuts).
3. Remove the retaining screw at the top (1 screw).
4. Remove the retaining screws at the bottom (2 screws).
5. Disconnect the plug-in connections for the fiber-optic cables and signal cables (2 plugs).
6. Remove the connection for the current transformer and associated PE connection (1 plug).
7. Unscrew the two retaining screws for the fan and attach the tool for de-installing the power block at this position.

You can now remove the power block.

CAUTION

When removing the power block, ensure that you do not damage any signal cables.

Installation steps

For installation, carry out the above steps in reverse order.

CAUTION

The tightening torques specified in the table "Tightening torques for connecting current-conducting parts" must be observed.
--

Carefully establish the plug-in connections and then ensure that they are secure.

The fiber-optic cable plugs must be remounted at their original slot. Fiber-optic cables and sockets are accordingly labeled for correct assignment (U11, U21, U31).
--

The screwed connections for the protective covers must only be tightened by hand.

Replacing the right-hand power block

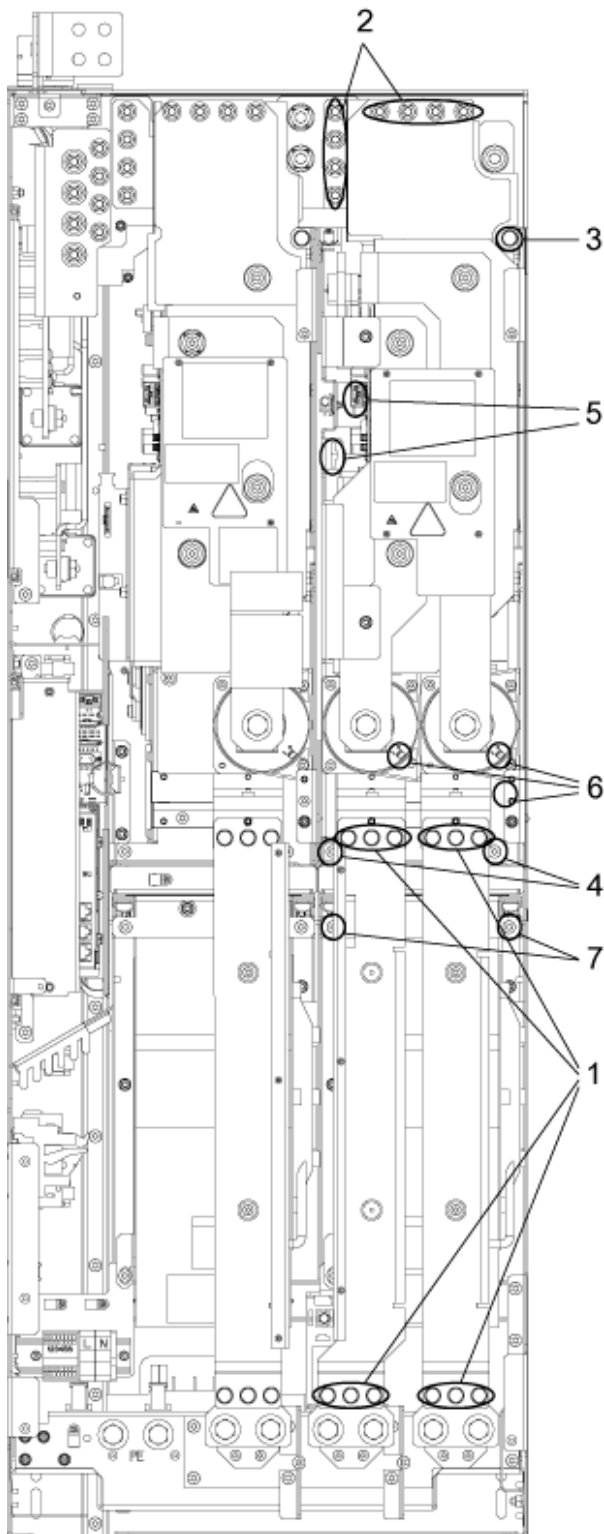


Figure 11-7 Replacing the power block (frame size HX) (right-hand power block)

Preparatory steps

- Disconnect the cabinet unit from the power supply.
- Allow unimpeded access to the power block.
- Remove the protective cover.

Removal steps

The removal steps are numbered in accordance with the figure.

1. Remove the busbars (12 screws).
2. Unscrew the connection to the DC link (8 nuts).
3. Remove the retaining screw at the top (1 screw).
4. Remove the retaining screws at the bottom (2 screws).
5. Disconnect the plug-in connections for the fiber-optic cables and signal cables (3 plugs).
6. Remove the connection for the current transformer and associated PE connection (2 plugs).
7. Unscrew the two retaining screws for the fan and attach the tool for de-installing the power block at this position.

You can now remove the power block.

CAUTION

When removing the power block, ensure that you do not damage any signal cables.

Installation steps

For installation, carry out the above steps in reverse order.

CAUTION

The tightening torques specified in the table "Tightening torques for connecting current-conducting parts" must be observed.
--

Carefully establish the plug-in connections and then ensure that they are secure.

The fiber-optic cable plugs must be remounted at their original slot. Fiber-optic cables and sockets are accordingly labeled for correct assignment (U11, U21, U31).
--

The screwed connections for the protective covers must only be tightened by hand.

11.4.5 Replacing the power block (frame size JX)

Replacing the power block

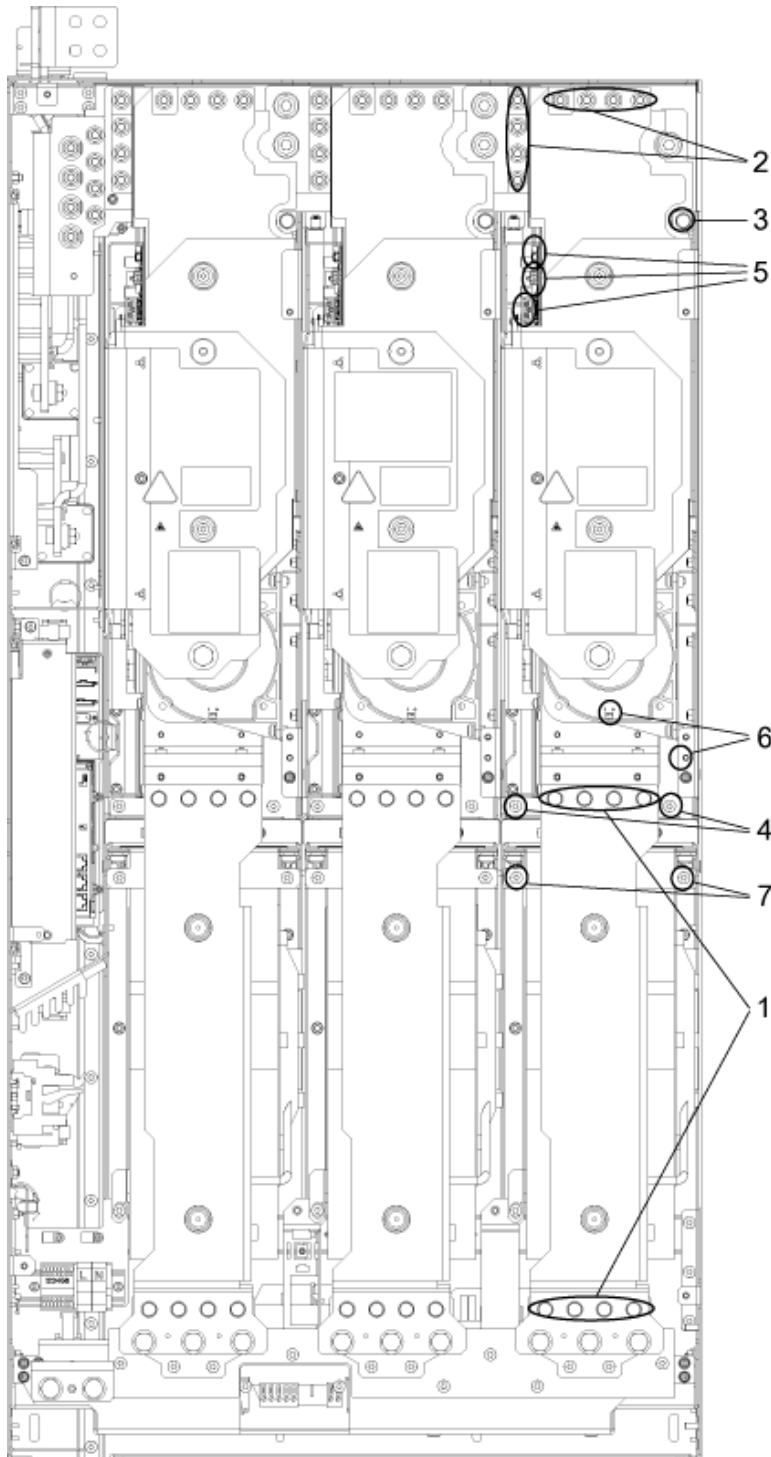


Figure 11-8 Replacing the power block (frame size JX)

Preparatory steps

- Disconnect the cabinet unit from the power supply.
- Allow unimpeded access to the power block.
- Remove the protective cover.

Removal steps

The removal steps are numbered in accordance with the figure.

1. Remove the busbar (8 screws).
2. Unscrew the connection to the DC link (8 nuts).
3. Remove the retaining screw at the top (1 screw).
4. Remove the retaining screws at the bottom (2 screws).
5. Disconnect the plug-in connections for the fiber-optic cables and signal cables (3 plugs).
6. Remove the connection for the current transformer and associated PE connection (1 plug).
7. Unscrew the two retaining screws for the fan and attach the tool for de-installing the power block at this position.

You can now remove the power block.

CAUTION

When removing the power block, ensure that you do not damage any signal cables.

Installation steps

For installation, carry out the above steps in reverse order.

CAUTION

The tightening torques specified in the table "Tightening torques for connecting current-conducting parts" must be observed.
--

Carefully establish the plug-in connections and then ensure that they are secure.

The fiber-optic cable plugs must be remounted at their original slot. Fiber-optic cables and sockets are accordingly labeled for correct assignment (U11, U21, U31).
--

The screwed connections for the protective covers must only be tightened by hand.

11.4.6 Replacing the Control Interface Board (frame size FX)

Replacing the Control Interface Board

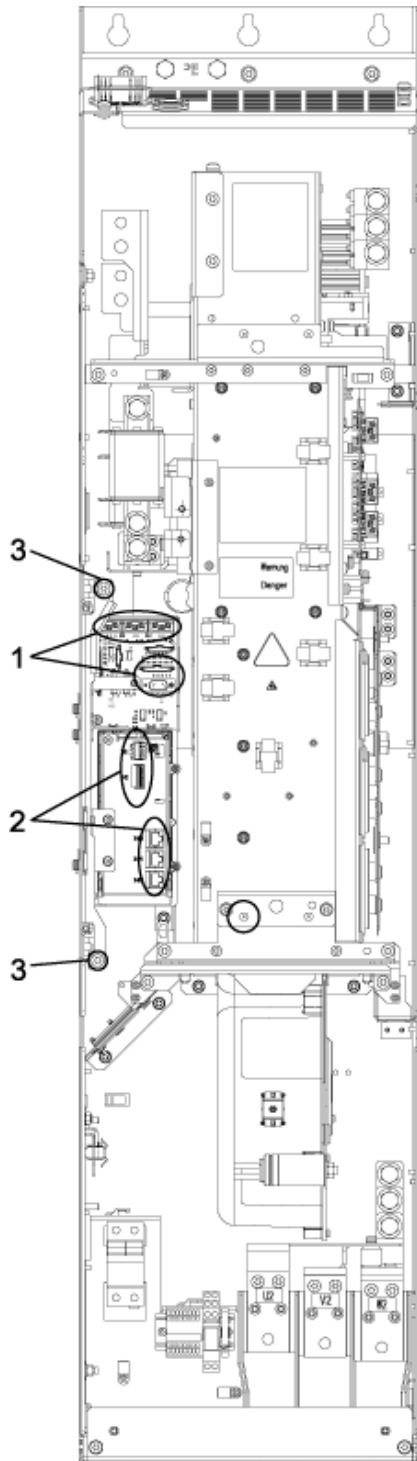


Figure 11-9 Replacing the control interface board (frame size FX)

Preparatory steps

- Disconnect the cabinet unit from the power supply.
- Allow unimpeded access.
- Remove the protective cover.

Removal steps

The removal steps are numbered in accordance with the figure.

1. Remove the CU320 mounts (1 screw and 2 nuts). If necessary, remove the PROFIBUS plug and connection to the operator panel (-X140 on the CU320) and remove the CU320.
2. Disconnect the plug-in connections for the fiber-optic cables and signal cables (5 plugs).
3. Remove the DRIVE-CLiQ cables and connections to the CU320 (5 plugs).
4. Remove the retaining screws for the slide-in electronics unit (2 screws).
When removing the slide-in electronics unit, you have to disconnect 5 further plugs one after the other (2 at the top, 3 below).

CAUTION

When removing the unit, ensure that you do not damage any signal cables.
--

The Control Interface Board can then be removed from the slide-in electronics unit.

CAUTION

When removing the ribbon cable's connectors, make sure that you actuate the locking lever on the connector very carefully (e.g. with a screwdriver) because otherwise the lock could be damaged.
--

Installation steps

For installation, carry out the above steps in reverse order.

CAUTION

The tightening torques specified in the table "Tightening torques for connecting current-conducting parts" must be observed.
--

Carefully establish the plug-in connections and then ensure that they are secure.

When dealing with connectors with a lock, make sure that the locking lever is securely engaged once connected.
--

The fiber-optic cable plugs must be remounted at their original slot. Fiber-optic cables and sockets are accordingly labeled for correct assignment (U11, U21, U31).
--

The screwed connections for the protective covers must only be tightened by hand.

11.4.7 Replacing the Control Interface Board (frame size GX)

Replacing the Control Interface Board

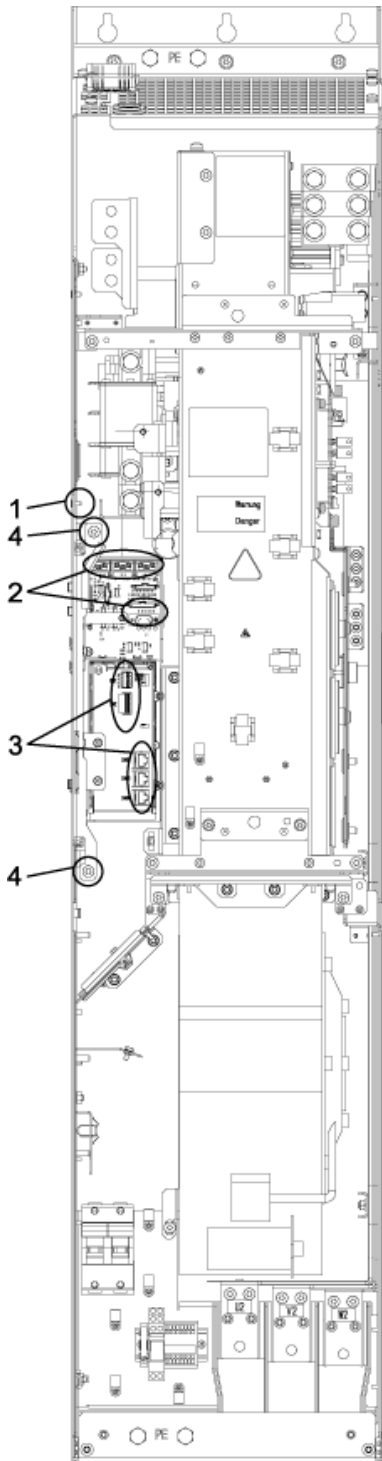


Figure 11-10 Replacing the Control Interface Board (frame size GX)

Preparatory steps

- Disconnect the cabinet unit from the power supply.
- Allow unimpeded access.
- Remove the protective cover.

Removal steps

The removal steps are numbered in accordance with the figure.

1. Remove the CU320 mount (1 nut). If necessary, remove the PROFIBUS plug and connection to the operator panel (-X140 on the CU320) and carefully remove the CU320.
2. Disconnect the plug-in connections for the fiber-optic cables and signal cables (5 plugs).
3. Remove the DRIVE-CLiQ cables and connections to the CU320 (5 plugs).
4. Remove the retaining screws for the slide-in electronics unit (2 screws).
When removing the slide-in electronics unit, you have to disconnect 5 further plugs one after the other (2 at the top, 3 below).

CAUTION

When removing the unit, ensure that you do not damage any signal cables.
--

The Control Interface Board can then be removed from the slide-in electronics unit.

CAUTION

When removing the ribbon cable's connectors, make sure that you actuate the locking lever on the connector very carefully (e.g. with a screwdriver) because otherwise the lock could be damaged.
--

Installation steps

For installation, carry out the above steps in reverse order.

CAUTION

The tightening torques specified in the table "Tightening torques for connecting current-conducting parts" must be observed.
--

Carefully establish the plug-in connections and then ensure that they are secure.

When dealing with connectors with a lock, make sure that the locking lever is securely engaged once connected.
--

The fiber-optic cable plugs must be remounted at their original slot. Fiber-optic cables and sockets are accordingly labeled for correct assignment (U11, U21, U31).
--

The screwed connections for the protective covers must only be tightened by hand.

11.4.8 Replacing the Control Interface Board (frame size HX)

Replacing the Control Interface Board

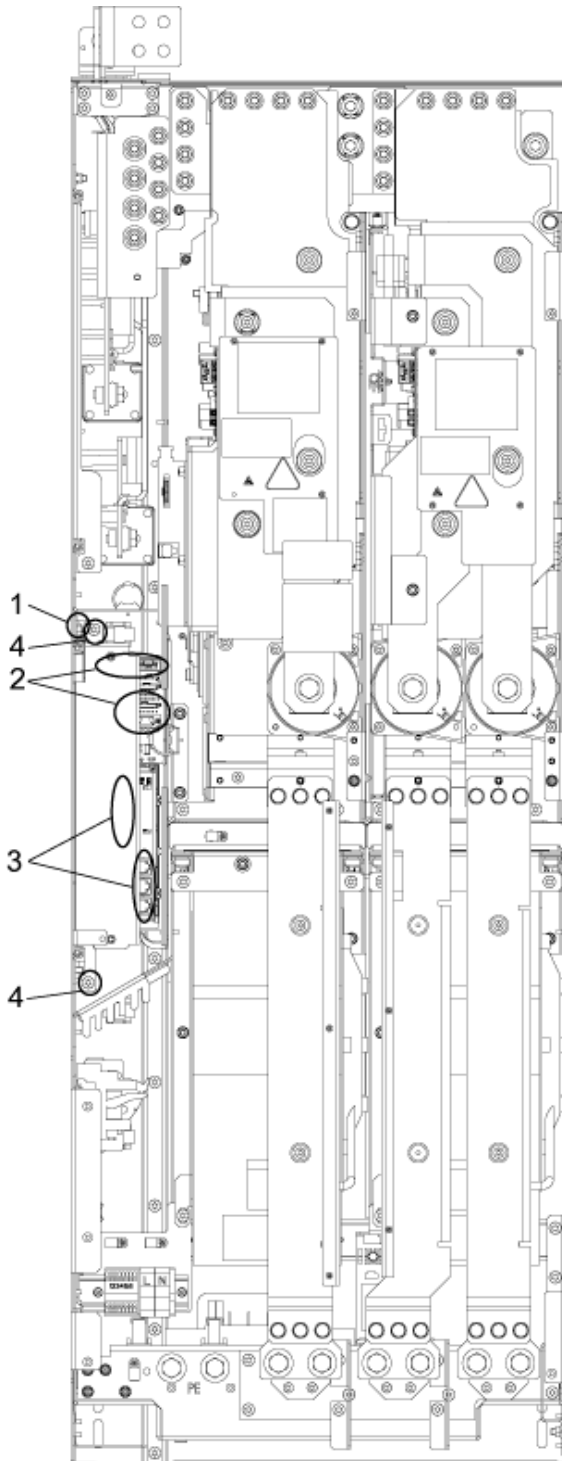


Figure 11-11 Replacing the Control Interface Board (frame size HX)

Preparatory steps

- Disconnect the cabinet unit from the power supply.
- Allow unimpeded access.
- Remove the protective cover.

Removal steps

The removal steps are numbered in accordance with the figure.

1. Remove the CU320 mount (1 nut). If necessary, remove the PROFIBUS plug and connection to the operator panel (-X140 on the CU320) and carefully remove the CU320.
2. Disconnect the plug-in connections for the fiber-optic cables and signal cables (5 plugs).
3. Remove the DRIVE-CLiQ cables and connections to the CU320 (5 plugs).
4. Remove the retaining screws for the slide-in electronics unit (2 screws).
When removing the slide-in electronics unit, you have to disconnect 5 further plugs one after the other (2 at the top, 3 below).

CAUTION

When removing the unit, ensure that you do not damage any signal cables.
--

The Control Interface Board can then be removed from the slide-in electronics unit.

CAUTION

When removing the ribbon cable's connectors, make sure that you actuate the locking lever on the connector very carefully (e.g. with a screwdriver) because otherwise the lock could be damaged.
--

Installation steps

For installation, carry out the above steps in reverse order.

CAUTION

The tightening torques specified in the table "Tightening torques for connecting current-conducting parts" must be observed.
--

Carefully establish the plug-in connections and then ensure that they are secure.

When dealing with connectors with a lock, make sure that the locking lever is securely engaged once connected.
--

The fiber-optic cable plugs must be remounted at their original slot. Fiber-optic cables and sockets are accordingly labeled for correct assignment (U11, U21, U31).
--

The screwed connections for the protective covers must only be tightened by hand.

11.4.9 Replacing the Control Interface Board (frame size JX)

Replacing the Control Interface Board

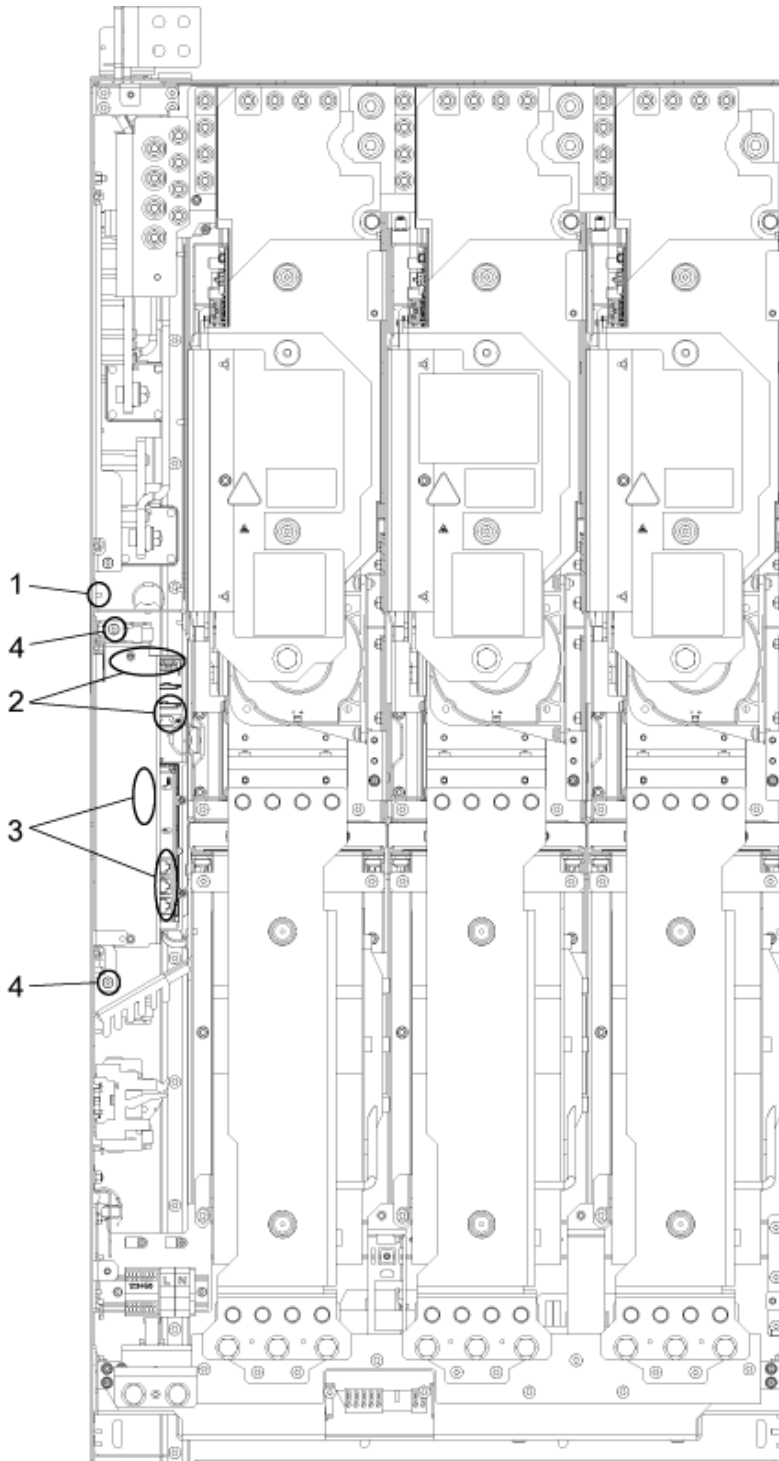


Figure 11-12 Replacing the Control Interface Board (frame size JX)

Preparatory steps

- Disconnect the cabinet unit from the power supply.
- Allow unimpeded access.
- Remove the protective cover.

Removal steps

The removal steps are numbered in accordance with the figure.

1. Remove the CU320 mount (1 nut). If necessary, remove the PROFIBUS plug and connection to the operator panel (-X140 on the CU320) and carefully remove the CU320.
2. Disconnect the plug-in connections for the fiber-optic cables and signal cables (5 plugs).
3. Remove the DRIVE-CLiQ cables and connections to the CU320 (5 plugs).
4. Remove the retaining screws for the slide-in electronics unit (2 screws).
When removing the slide-in electronics unit, you have to disconnect 5 further plugs one after the other (2 at the top, 3 below).

CAUTION

When removing the unit, ensure that you do not damage any signal cables.
--

The Control Interface Board can then be removed from the slide-in electronics unit.

CAUTION

When removing the ribbon cable's connectors, make sure that you actuate the locking lever on the connector very carefully (e.g. with a screwdriver) because otherwise the lock could be damaged.
--

Installation steps

For installation, carry out the above steps in reverse order.

CAUTION

The tightening torques specified in the table "Tightening torques for connecting current-conducting parts" must be observed.
--

Carefully establish the plug-in connections and then ensure that they are secure.

When dealing with connectors with a lock, make sure that the locking lever is securely engaged once connected.
--

The fiber-optic cable plugs must be remounted at their original slot. Fiber-optic cables and sockets are accordingly labeled for correct assignment (U11, U21, U31).
--

The screwed connections for the protective covers must only be tightened by hand.

11.4.10 Replacing the fan (frame size FX)

Replacing the fan

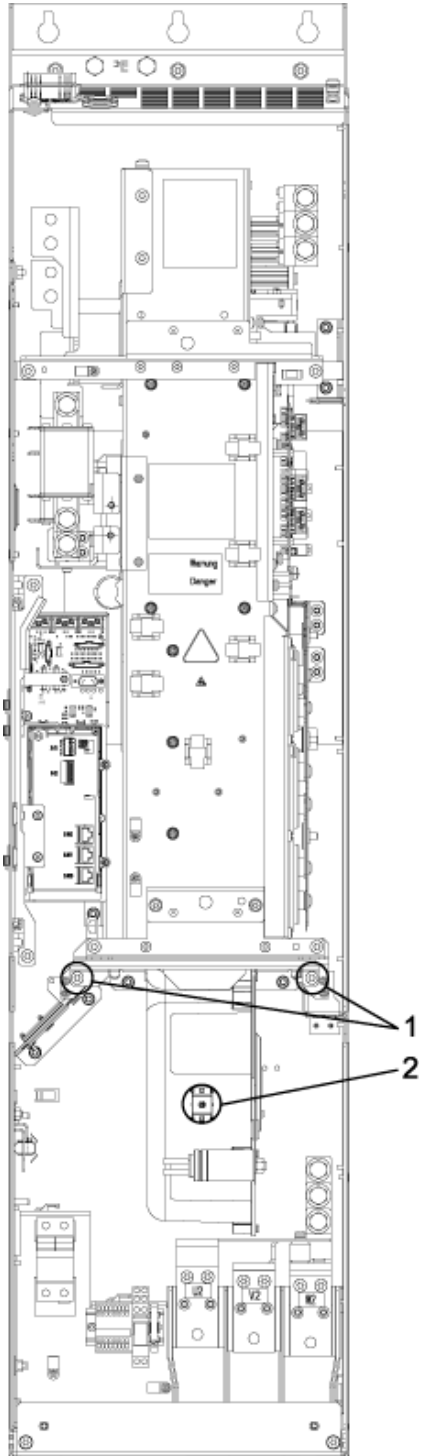


Figure 11-13 Replacing the fan (frame size FX)

Description

The average service life of the device fans is 50,000 hours. In practice, however, the service life depends on other variables (e.g. ambient temperature, degree of cabinet protection, etc.) and, therefore, may deviate from this value.

The fans must be replaced in good time to ensure that the cabinet unit is available.

Preparatory steps

- Disconnect the cabinet unit from the power supply.
- Allow unimpeded access.
- Remove the protective cover.

Removal

The steps for the removal procedure are numbered in accordance with the diagram.

1. Remove the retaining screws for the fan (2 screws).
2. Disconnect the supply cables (1 x "L", 1 x "N").

You can now carefully remove the fan.

CAUTION

When removing the fan, ensure that you do not damage any signal cables.

Installation

For re-installation, carry out the above steps in reverse order.

CAUTION

The tightening torques specified in the table "Tightening torques for connecting current-carrying parts" must be observed.
--

Carefully re-establish the plug connections and ensure that they are secure.
--

The screwed connections for the protective covers must only be tightened by hand.

11.4.11 Replacing the fan (frame size GX)

Replacing the fan

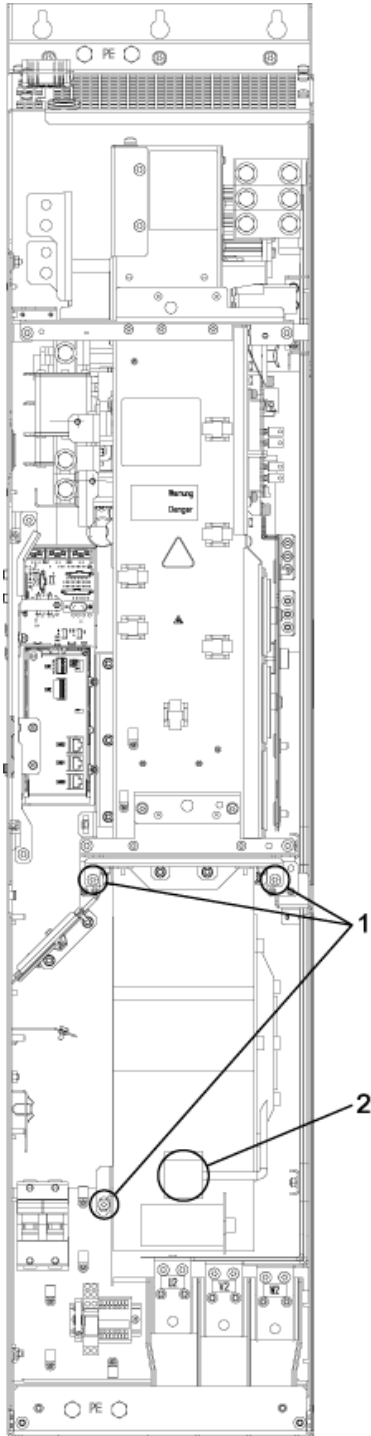


Figure 11-14 Replacing the fan (frame size GX)

Description

The average service life of the device fans is 50,000 hours. In practice, however, the service life depends on other variables (e.g. ambient temperature, degree of cabinet protection, etc.) and, therefore, may deviate from this value.

The fans must be replaced in good time to ensure that the cabinet unit is available.

Preparatory steps

- Disconnect the cabinet unit from the power supply.
- Allow unimpeded access.
- Remove the protective cover.

Removal

The steps for the removal procedure are numbered in accordance with the diagram.

1. Remove the retaining screws for the fan (3 screws).
2. Disconnect the supply cables (1 x "L", 1 x "N").

You can now carefully remove the fan.

CAUTION

When removing the fan, ensure that you do not damage any signal cables.

Installation

For re-installation, carry out the above steps in reverse order.

CAUTION

The tightening torques specified in the table "Tightening torques for connecting current-carrying parts" must be observed.
--

Carefully re-establish the plug connections and ensure that they are secure.
--

The screwed connections for the protective covers must only be tightened by hand.

11.4.12 Replacing the fan (frame size HX)

Replacing the fan (left-hand power block)

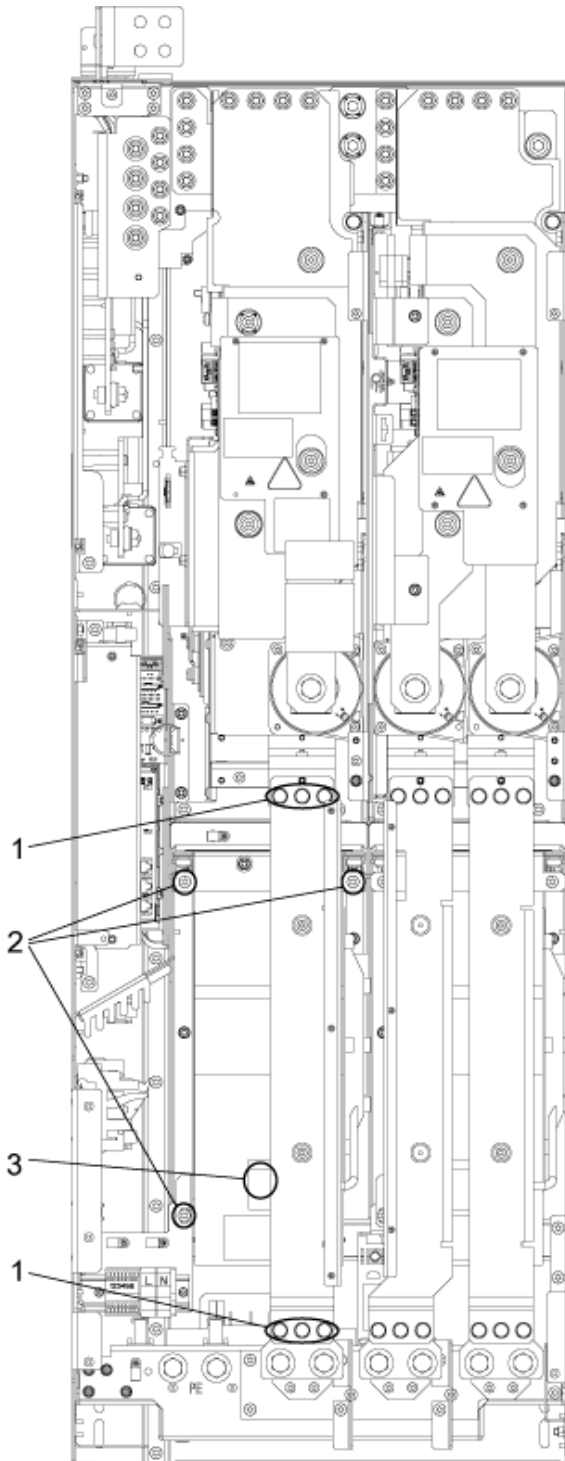


Figure 11-15 Replacing the fan (frame size HX) (left-hand power block)

Description

The average service life of the device fans is 50,000 hours. In practice, however, the service life depends on other variables (e.g. ambient temperature, degree of cabinet protection, etc.) and, therefore, may deviate from this value.

The fans must be replaced in good time to ensure that the cabinet unit is available.

Preparatory steps

- Disconnect the cabinet unit from the power supply.
- Allow unimpeded access.
- Remove the protective cover.

Removal steps

The removal steps are numbered in accordance with the figure.

1. Remove the busbar (6 screws).
2. Remove the retaining screws for the fan (3 screws).
3. Disconnect the supply cables (1 x "L", 1 x "N").

You can now carefully remove the fan.

CAUTION

When removing the unit, ensure that you do not damage any signal cables.
--

Installation steps

For installation, carry out the above steps in reverse order.

CAUTION

The tightening torques specified in the table "Tightening torques for connecting current-conducting parts" must be observed.
--

Carefully establish the plug-in connections and then ensure that they are secure.

The screwed connections for the protective covers must only be tightened by hand.

Replacing the fan (right-hand power block)

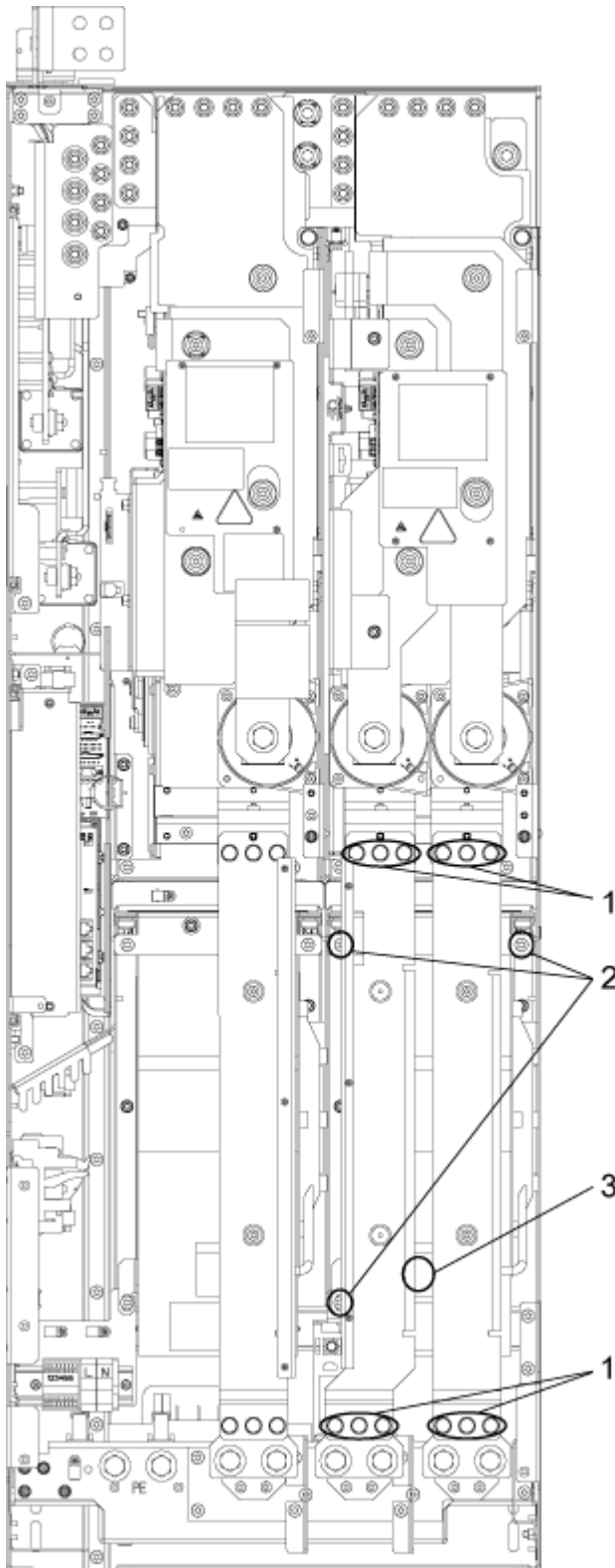


Figure 11-16 Replacing the fan (frame size HX) (right-hand power block)

Description

The average service life of the device fans is 50,000 hours. In practice, however, the service life depends on other variables (e.g. ambient temperature, degree of cabinet protection, etc.) and, therefore, may deviate from this value.

The fans must be replaced in good time to ensure that the cabinet unit is available.

Preparatory steps

- Disconnect the cabinet unit from the power supply.
- Allow unimpeded access.
- Remove the protective cover.

Removal steps

The removal steps are numbered in accordance with the figure.

1. Remove the busbars (12 screws).
2. Remove the retaining screws for the fan (3 screws).
3. Disconnect the supply cables (1 x "L", 1 x "N").

You can now carefully remove the fan.

CAUTION

When removing the unit, ensure that you do not damage any signal cables.
--

Installation steps

For installation, carry out the above steps in reverse order.

CAUTION

The tightening torques specified in the table "Tightening torques for connecting current-conducting parts" must be observed.
--

Carefully establish the plug-in connections and then ensure that they are secure.

The screwed connections for the protective covers must only be tightened by hand.

11.4.13 Replacing the fan (frame size JX)

Replacing the fan

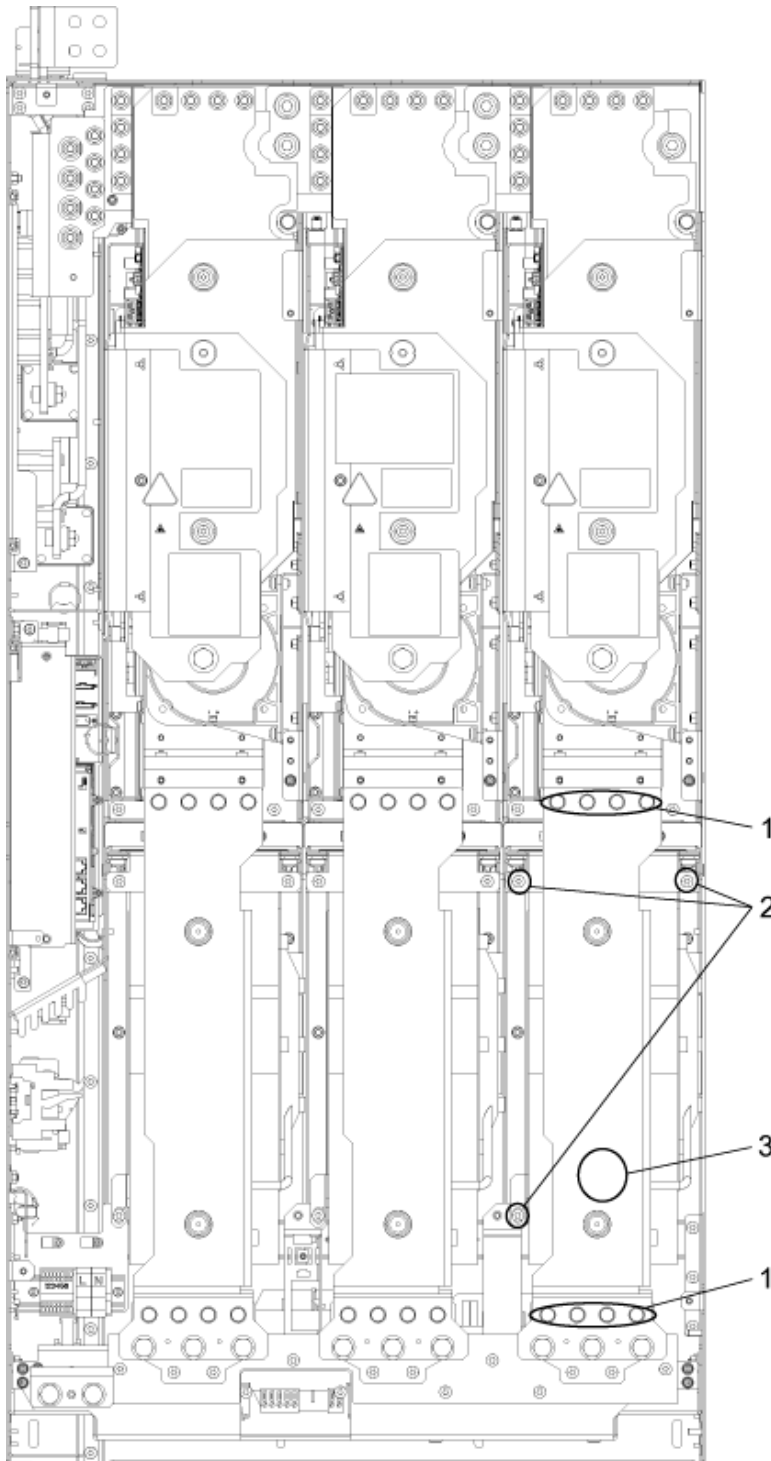


Figure 11-17 Replacing the fan (frame size JX)

Description

The average service life of the device fans is 50,000 hours. In practice, however, the service life depends on other variables (e.g. ambient temperature, degree of cabinet protection, etc.) and, therefore, may deviate from this value.

The fans must be replaced in good time to ensure that the cabinet unit is available.

Preparatory steps

- Disconnect the cabinet unit from the power supply.
- Allow unimpeded access.
- Remove the protective cover.

Removal steps

The removal steps are numbered in accordance with the figure.

1. Remove the busbar (8 screws).
2. Remove the retaining screws for the fan (3 screws).
3. Disconnect the supply cables (1 x "L", 1 x "N").

You can now carefully remove the fan.

CAUTION

When removing the unit, ensure that you do not damage any signal cables.
--

Installation steps

For installation, carry out the above steps in reverse order.

CAUTION

The tightening torques specified in the table "Tightening torques for connecting current-conducting parts" must be observed.
--

Carefully establish the plug-in connections and then ensure that they are secure.

The screwed connections for the protective covers must only be tightened by hand.

11.4.14 Replacing the fan in the Active Interface Module (frame size FI)

Replacing the fan

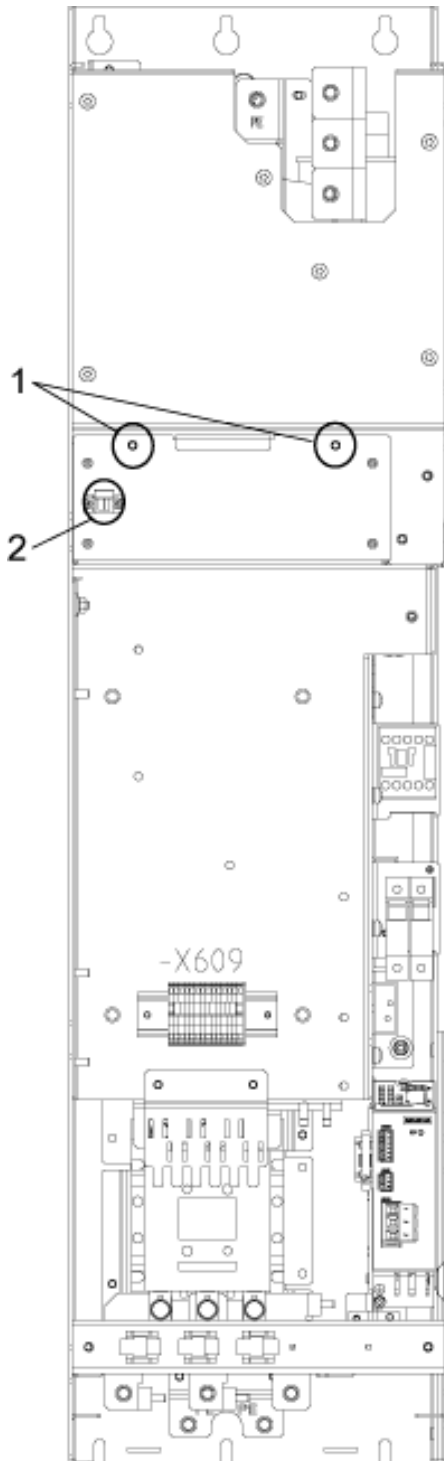


Figure 11-18 Replacing the fan in the Active Interface Module (frame size FI)

Description

The average service life of the device fans is 50,000 hours. In practice, however, the service life depends on other variables (e.g. ambient temperature, degree of cabinet protection, etc.) and, therefore, may deviate from this value.

The fans must be replaced in good time to ensure that the cabinet unit is available.

Preparatory steps

- Disconnect the cabinet unit from the power supply.
- Allow unimpeded access.
- Remove the protective cover.

Removal

The steps for the removal procedure are numbered in accordance with the diagram.

1. Remove the retaining screws for the fan unit (2 screws).
2. Unplug connector –X630.

You can now carefully remove the fan unit.

CAUTION

When removing the fan unit, ensure that the cables are not damaged.

Installation

For re-installation, carry out the above steps in reverse order.

CAUTION

The tightening torques specified in the table "Tightening torques for connecting current-carrying parts" must be observed.
--

Carefully re-establish the plug connections and ensure that they are secure.
--

The screwed connections for the protective covers must only be tightened by hand.

11.4.15 Replacing the fan in the Active Interface Module (frame size GI)

Replacing the fan

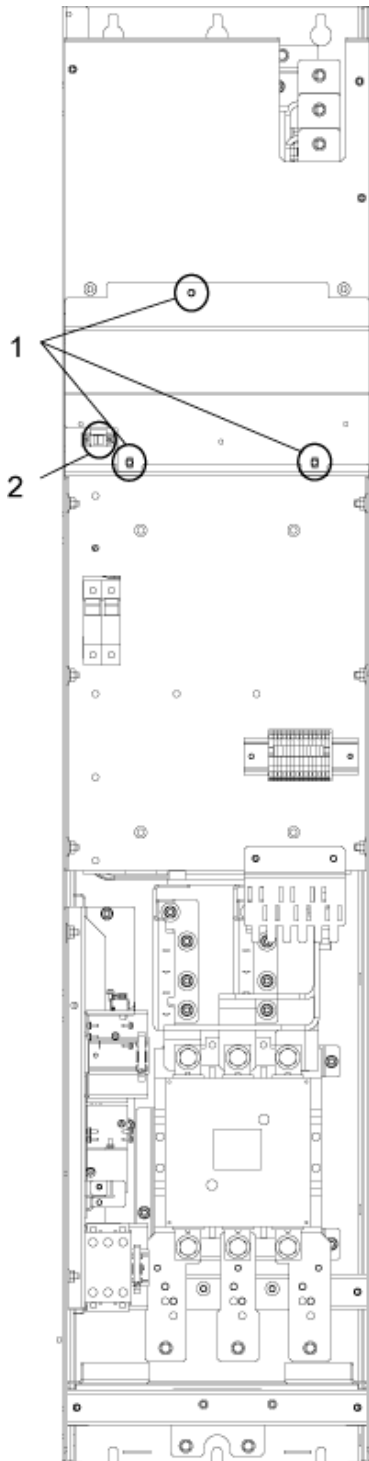


Figure 11-19 Replacing the fan in the Active Interface Module (frame size GI)

Description

The average service life of the device fans is 50,000 hours. In practice, however, the service life depends on other variables (e.g. ambient temperature, degree of cabinet protection, etc.) and, therefore, may deviate from this value.

The fans must be replaced in good time to ensure that the cabinet unit is available.

Preparatory steps

- Disconnect the cabinet unit from the power supply.
- Allow unimpeded access.
- Remove the protective cover.

Removal

The steps for the removal procedure are numbered in accordance with the diagram.

1. Remove the retaining screws for the fan unit (3 screws).
2. Unplug connector –X630.

You can now carefully remove the fan unit.

CAUTION

When removing the fan unit, ensure that the cables are not damaged.

Installation

For re-installation, carry out the above steps in reverse order.

CAUTION

The tightening torques specified in the table "Tightening torques for connecting current-carrying parts" must be observed.
--

Carefully re-establish the plug connections and ensure that they are secure.
--

The screwed connections for the protective covers must only be tightened by hand.

11.4.16 Replacing the fan in the Active Interface Module (frame size HI)_S150

Replacing the fan

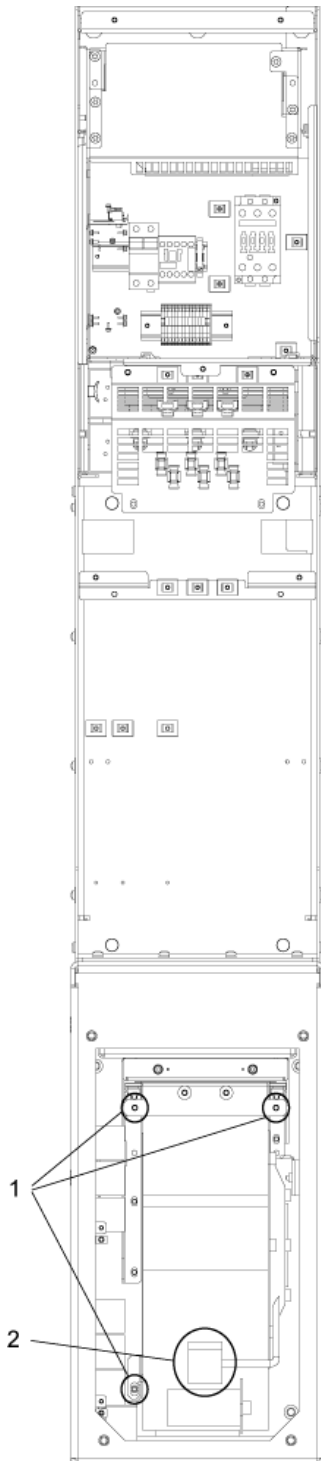


Figure 11-20 Replacing the fan in the Active Interface Module (frame size HI)

Description

The average service life of the device fans is 50,000 hours. In practice, however, the service life depends on other variables (e.g. ambient temperature, degree of cabinet protection, etc.) and, therefore, may deviate from this value.

The fans must be replaced in good time to ensure that the cabinet unit is available.

Preparatory steps

- Disconnect the cabinet unit from the power supply.
- Allow unimpeded access.
- Remove the protective cover.

Removal

The steps for the removal procedure are numbered in accordance with the diagram.

1. Remove the retaining screws for the fan (3 screws).
2. Disconnect the supply cables (1 x "L", 1 x "N").

You can now carefully remove the fan.

CAUTION
When removing the fan, ensure that the cables are not damaged.

Installation

For re-installation, carry out the above steps in reverse order.

CAUTION
The tightening torques specified in the table "Tightening torques for connecting current-carrying parts" must be observed.
Carefully re-establish the plug connections and ensure that they are secure.
The screwed connections for the protective covers must only be tightened by hand.

11.4.17 Replacing the fan in the Active Interface Module (frame size JI)

Replacing the fan

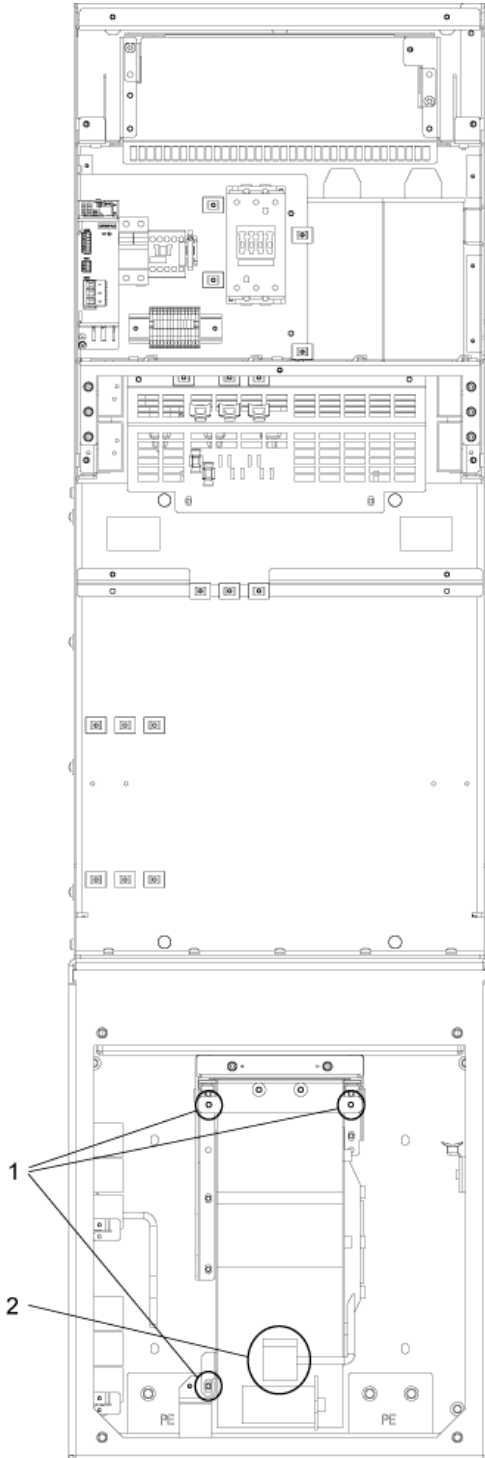


Figure 11-21 Replacing the fan in the Active Interface Module (frame size JI)

Description

The average service life of the device fans is 50,000 hours. In practice, however, the service life depends on other variables (e.g. ambient temperature, degree of cabinet protection, etc.) and, therefore, may deviate from this value.

The fans must be replaced in good time to ensure that the cabinet unit is available.

Preparatory steps

- Disconnect the cabinet unit from the power supply.
- Allow unimpeded access.
- Remove the protective cover.

Removal

The steps for the removal procedure are numbered in accordance with the diagram.

1. Remove the retaining screws for the fan (3 screws).
2. Disconnect the supply cables (1 x "L", 1 x "N").

You can now carefully remove the fan.

CAUTION

When removing the fan, ensure that the cables are not damaged.
--

Installation

For re-installation, carry out the above steps in reverse order.

CAUTION

The tightening torques specified in the table "Tightening torques for connecting current-carrying parts" must be observed.
--

Carefully re-establish the plug connections and ensure that they are secure.
--

The screwed connections for the protective covers must only be tightened by hand.

11.4.18 Replacing the fan fuses (-A2 -F101/F102, -G1 -F10/F11, -T1 -F10/F11)

The order numbers for replacement fan fuses can be found in the spare parts list.)

 **WARNING**

Make sure that the cause of the fault is found before the fuse is replaced.

11.4.19 Replacing the fuses for the auxiliary power supply (-A1 -F11 / -A1 -F12)

The order numbers for replacing auxiliary power supply fuses that have blown can be found in the spare parts list.

 **WARNING**

You must carry out the following:

- First disconnect the auxiliary power supply.
- Then rectify the cause of the fault.
- Replace the fuse.

11.4.20 Replacing the main fuses

Preparatory steps

- Disconnect the cabinet unit from the power supply.
- Open the cabinet door.
- Remove the protective cover.

Removal

1. Insert the holder for the main fuse.
2. Remove the main fuse.

Installation

1. Insert the new main fuse into the holder.
2. Insert the holder for the main fuse in the cabinet.

11.4.21 Replacing the cabinet operator panel

1. Switch the unit into a no-voltage condition.
2. Open the cabinet.
3. Disconnect the power supply and communications line on the operator panel.
4. Release the fastenings on the operator panel.
5. Remove the operator panel.
6. Install the new operator panel.
7. Carry out any other work by reversing the sequence.

11.4.22 Replacing the Backup Battery for the Cabinet Operator Panel

Table 11- 2 Technical specifications of the backup battery

Type	CR2032 3 V lithium battery
Manufacturer	Maxell, Sony, Panasonic
Nominal capacity	220 mAh
Maximum permissible charging current	10 mA (restricted to <2 mA in operator panel)
Self-discharge at 20 °C	1 %/year
Service life (in backup mode)	> 1 year at 70 °C; >1.5 years at 20 °C
Service life (in operation)	> 2 years

Replacing

1. Switch the unit into a no-voltage condition.
2. Open the cabinet.
3. Disconnect the 24 V DC power supply and communications line on the operator panel.
4. Open the cover of the battery compartment.
5. Remove the old battery.
6. Insert the new battery.
7. Close the cover of the battery compartment.
8. Reconnect the 24 V DC power supply and communications line.
9. Close the cabinet.

NOTICE

The battery must be replaced within one minute to ensure that no AOP settings are lost.

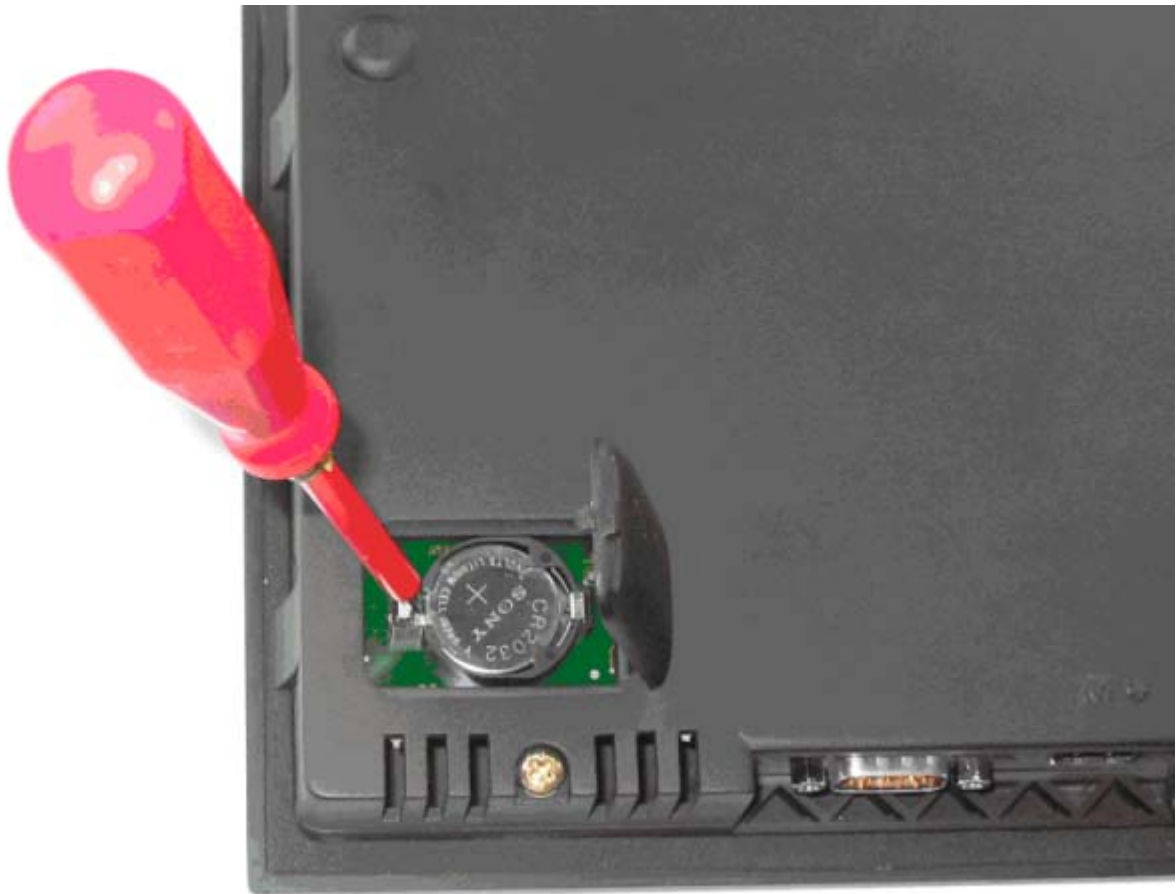


Figure 11-22 Replacing the backup battery for the cabinet operator panel

11.5 Forming the DC link capacitors

Description

If the device is kept in storage for more than 2 years, the DC link capacitors have to be re-formed. If this is not done, the unit could be damaged when it is operated under load.

If the cabinet is commissioned within two years of its date of manufacture, the DC link capacitors do not need to be re-formed. The date of manufacture is indicated in the serial number on the type plate (see "Device Overview").

Note

It is important that the storage period is calculated from the date of manufacture and not from the date that the equipment was shipped.

Procedure

The DC link capacitors are re-formed by applying the rated voltage without load for at least 30 minutes at room temperature.

- Operation via PROFIBUS:
 - Set bit 3 of control word 1 (operation enable) permanently to "0".
 - Switch on the converter by means of an ON signal (bit 0 of the control word); all the other bits must be set in such a way that the converter can be operated.
 - Once the delay time has elapsed, switch off the converter and restore the original PROFIBUS setting.
- Operation via terminal block:
 - Set p0852 to "0" (factory setting is "1").
 - Switch on the converter (via digital input 0 on the customer terminal block).
 - Once the delay time has elapsed, switch off the converter and restore the original setting for p0852.

Note

Reforming cannot be carried out in LOCAL mode via the AOP30.

11.6 Messages after replacing DRIVE-CLiQ components

After DRIVE-CLiQ components are replaced (Control Interface Board, TM31, SMCxx) when service is required, generally, after power-up, a message is not output.

The reason for this is that an identical component is detected and accepted as spare part when running-up. If, unexpectedly, a fault message of the "topology fault" category is displayed, then when replacing a component, one of the following faults/errors should have occurred:

- A Control Interface Board with different firmware data was installed.
- When connecting-up DRIVE-CLiQ cables, connections were interchanged.

Automatic firmware update

As of firmware 2.5, an automatic firmware update can be carried out once the electronics have been powered up on replacement DRIVE-CLiQ components.

- The following LEDs will flash slowly to indicate that an automatic firmware update is in progress: the "RDY" LED on the Control Unit (orange, 0.5 Hz) and an LED on the relevant DRIVE-CLiQ component (green/red, 0.5 Hz).

CAUTION
The drive converter must not be shut down during this process!

- Once the automatic firmware update is complete, the "RDY" LED on the Control Unit will flash quickly (orange, 2 Hz) along with an LED on the relevant DRIVE-CLiQ component (green/red, 2 Hz).
- To complete the automatic firmware update process, a POWER ON is required (switch the device off and back on again).

11.7 Upgrading the cabinet unit firmware

When you upgrade the cabinet unit firmware (by installing a new CompactFlash Card with a new firmware version, for example), you might also have to upgrade the firmware for the DRIVE-CLiQ components in the cabinet unit.

If the system detects that the firmware in the DRIVE-CLiQ components needs to be updated, it will trigger this process automatically when the automatic firmware update is performed.

Automatic firmware update sequence

1. During an automatic firmware update, the "RDY" LED on the CU320 Control Unit flashes slowly (orange, 0.5 Hz).
2. The firmware update is performed automatically and in sequence on the DRIVE-CLiQ components; during the update process, an LED on the component whose firmware is being updated will flash slowly (green/red, 0.5 Hz).
3. Once the firmware update on an individual DRIVE-CLiQ component is complete, the LED on that component will flash quickly (green/red, 2 Hz).
4. Once the firmware update on all components is complete, the LED on the CU320 Control Unit will flash quickly (orange, 2 Hz).
5. To complete the automatic firmware update process, a POWER ON is required (switch the device off and back on again).

CAUTION
The power supply to the components must not be interrupted while the firmware is being upgraded.

CAUTION
New firmware should only be installed if there is a problem with the cabinet unit.

11.8 Loading the new operator panel firmware from the PC.

Description

Firmware might need to be loaded to the AOP if the AOP functionality needs to be upgraded.

If, once the drive has powered up, the CompactFlash Card is found to contain a newer version of the firmware, a message will appear on the AOP30 prompting you to load the new firmware. You should click "YES" in response to this prompt.

The firmware will then be loaded automatically on the operator panel and the following dialog screen will appear.

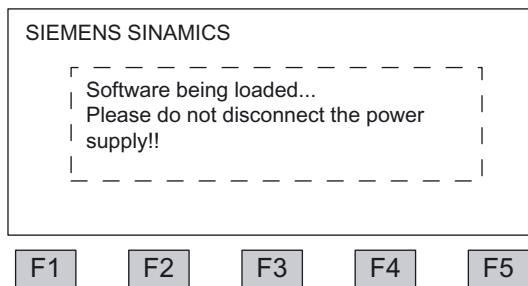


Figure 11-23 Dialog screen: loading firmware

If the firmware cannot be loaded successfully, it can be loaded using the following manual method.

The load program LOAD_AOP30 and the firmware file can be found on the CD.

Loading the firmware

1. Establish the RS232 connection from the PC to the AOP30.
2. Provide the supply voltage (24 V DC).
3. Start the LOAD_AOP30 program on the PC.
4. Choose the PC interface (COM1, COM2).
5. Choose and open the firmware (AOP30.H86).
6. Follow the instructions in the status window of the program and connect the power supply for the AOP30 while pressing the red key (O).
7. The load procedure is started automatically.
8. Switch the power on (switch the power supply off and then back on).

Technical specifications

12.1 Chapter content

This chapter provides information on the following:

- General and specific technical specifications for the devices.
- Information on restrictions that apply when the devices are used in unfavorable ambient conditions (derating)

12.2 General technical specifications

Table 12- 1 General technical specifications

Electrical data			
Line system configurations	TN/TT supplies or insulated supplies (IT supplies)		
Line frequency	47 Hz to 63 Hz		
Output frequency	0 Hz to 300 Hz		
Power factor	Variable via reactive current (factory setting: $\cos \varphi = 1$)		
Switching at input	Once every 3 minutes		
Mechanical data			
Degree of protection	IP20 (higher degrees of protection up to IP54 optional)		
Class of protection	I to EN 50178, Part 1		
Cooling method	Forced air cooling AF to EN 60146		
Sound pressure level L_{pA} (1 m)	≤ 78 dB(A) at 50 Hz line frequency ≤ 80 dB(A) at 60 Hz line frequency		
Touch protection	BGV A3		
Cabinet system	Rittal TS 8, doors with double-barb lock, three-section base plates for cable entry		
Paint finish	RAL 7035 (indoor requirements)		
Compliance with standards			
Standards	EN 60146-1, EN 61800-2, EN 61800-3, EN 50178 ¹⁾ , EN 60204-1, EN 60529 ²⁾		
CE mark	To EMC directive No. 2004/108/EC and low-voltage directive No. 2006/95/EC		
RI suppression	In accordance with the EMC product standard for variable-speed drives EN 61800-3, "second environment". Application in "first environment" possible with line filters (option L00).		
Ambient conditions	Storage	Transport	During operation
Ambient temperature	-25 ... +55 °C	-25 ... +70 °C as of -40 °C for 24 hours	0 ... +40 °C up to +50 °C with derating
Humidity range ²⁾ (non-condensing) corresponds to class	5 to 95 % 1K4 to EN 60721-3-1	5 ... 95 % at 40 °C 2K3 to EN 60721-3-2	5 ... 95 % 3K3 to EN 60721-3-3
Environmental class/harmful chemical substances ²⁾	1C2 to EN 60721-3-1	2C2 to EN 60721-3-2	3C2 to EN 60721-3-3
Organic/biological influences ²⁾	1B1 to EN 60721-3-1	2B1 to EN 60721-3-2	3B1 to EN 60721-3-3
Installation altitude	Up to 2000 m above sea level without derating, > 2000 m above sea level with derating (see "Derating data")		

Mechanical stability	Storage	Transport	During operation
Vibrational load ²⁾ - Displacement - Acceleration corresponds to class	1.5 mm at 5 to 9 Hz 5 m/s ² at > 9 to 200 Hz 1M2 to EN 60721-3-1	<i>3.1 mm</i> at 5 ... 9 Hz 10 m/s ² at > 9 ... 200 Hz 2M2 to EN 60721-3-2	0.075 mm at 10 ... 58 Hz 10 m/s ² at >58 ... 200 Hz -
Shock load ²⁾ - Acceleration corresponds to class	40 m/s ² at 22 ms 1M2 to EN 60721-3-1	100 m/s ² at 11 ms 2M2 to EN 60721-3-2	100 m/s ² at 11 ms 3M4 to EN 60721-3-3

Deviations from the defined classes are shown in *italics*.

1) The EN standard specified is the European edition of international standard IEC 62103.

2) The EN standards specified are the European editions of the international IEC standards with the same designations.

12.2.1 Derating data

Current derating as a function of the installation altitude and ambient temperature

If the cabinet units are operated at a installation altitude >2000 m above sea level, the maximum permissible output current can be calculated using the following tables. The installation altitude and ambient temperature are compensated here. The degree of protection selected for the cabinet units must also be taken into account.

Table 12- 2 Current derating as a function of ambient temperature (inlet air temperature at the air inlet of the cabinet unit) and installation altitude for cabinet units with degree of protection IP20/IP21/IP23/IP43

Installation altitude above sea level in m	Ambient temperature in °C						
	20	25	30	35	40	45	50
0 to 2000	100 %					95,0 %	87,0 %
Up to 2500	100 %				96.3 %	91,4 %	83,7 %
Up to 3000	100 %			96.2 %	92.5 %	87,9 %	80,5 %
Up to 3500	100 %		96.7 %	92.3 %	88.8 %	84,3 %	77.3 %
Up to 4000	100 %	97.8 %	92.7 %	88.4 %	85.0 %	80.8 %	74.0 %

Table 12- 3 Current derating as a function of the ambient temperature (inlet air temperature at the air inlet of the cabinet unit) and installation altitude for cabinet units with degree of protection IP54

Installation altitude above sea level in m	Ambient temperature in °C							
	20	25	30	35	40	45	50	
0 to 2000	100 %					95.0 %	87.5 %	80.0 %
Up to 2500	100 %				96.3 %	91.4 %	84.2 %	77.0 %
Up to 3000	100 %			96.2 %	92.5 %	87.9 %	81.0 %	74.1 %
Up to 3500	100 %	96.7 %	92.3 %	88.8 %	84.3 %	77.7 %	71.1 %	
Up to 4000	97.8 %	92.7 %	88.4 %	85.0 %	80.8 %	74.7 %	68.0 %	

Voltage derating as a function of the installation altitude

In addition to current derating, voltage derating must also be considered at installation altitudes >2000 m above sea level.

Table 12- 4 Voltage derating as a function of the installation altitude (380 V – 480 V 3 AC)

Installation altitude above sea level in m	Rated converter input voltage					
	380 V	400 V	420 V	440 V	460 V	480 V
0 to 2000	100 %					
Up to 2250	100 %					96 %
Up to 2500	100 %				98 %	94 %
Up to 2750	100 %			98 %	94 %	90 %
Up to 3000	100 %			95 %	91 %	88 %
Up to 3250	100 %		97 %	93 %	89 %	85 %
Up to 3500	100 %	98 %	93 %	89 %	85 %	82 %
Up to 3750	100 %	95 %	91 %	87 %	83 %	79 %
Up to 4000	96 %	92 %	87 %	83 %	80 %	76 %

Table 12- 5 Voltage derating as a function of the installation altitude (500 V – 690 V 3 AC)

Installation altitude above sea level in m	Rated converter input voltage					
	500 V	525 V	575 V	600 V	660 V	690 V
0 to 2000	100 %					
Up to 2250	100 %					96 %
Up to 2500	100 %				98 %	94 %
Up to 2750	100 %				94 %	90 %
Up to 3000	100 %				91 %	88 %
Up to 3250	100 %			98 %	89 %	85 %
Up to 3500	100 %		98 %	94 %	85 %	82 %
Up to 3750	100 %		95 %	91 %	83 %	79 %
Up to 4000	100 %		91 %	87 %	80 %	76 %

Note

On systems with a grounded phase conductor and a line voltage >600 V AC, line-side components should be installed to limit overvoltages to overvoltage category II in accordance with IEC 60664-1.

Current derating as a function of the pulse frequency

When the pulse frequency is increased, the derating factor of the output current must be taken into account. This derating factor must be applied to the currents specified in the technical specifications for the cabinet units.

Table 12- 6 Derating factor of the output current as a function of the pulse frequency for devices with a rated pulse frequency of 2 kHz

Order no. 6SL3710-...	Power [kW]	Output current at 2 kHz [A]	Derating factor at 4 kHz
Supply voltage 380 V – 480 V 3 AC			
7LE32-1AA0	110	210	82 %
7LE32-6AA0	132	260	83 %
7LE33-1AA0	160	310	88 %
7LE33-8AA0	200	380	87 %
7LE35-0AA0	250	490	78 %

Table 12- 7 Derating factor of the output current as a function of the pulse frequency for units with a rated pulse frequency of 1.25 kHz

Order no. 6SL3710-...	Power [kW]	Output current at 1.25 kHz [A]	Derating factor at 2.5 kHz	Derating factor at 5 kHz
Supply voltage 380 V – 480 V 3 AC				
7LE36-1AA0	315	605	72 %	60 %
7LE37-5AA0	400	745	72 %	60 %
7LE38-4AA0	450	840	79 %	55 %
7LE41-0AA0	560	985	87 %	60 %
7LE41-2AA0	710	1260	87 %	60 %
7LE41-4AA0	800	1405	95 %	60 %
Supply voltage 500 – 690 V 3 AC				
7LG28-5AA0	75	85	89 %	60 %
7LG31-0AA0	90	100	88 %	60 %
7LG31-2AA0	110	120	88 %	60 %
7LG31-5AA0	132	150	84 %	55 %
7LG31-8AA0	160	175	87 %	60 %
7LG32-2AA0	200	215	87 %	60 %
7LG32-6AA0	250	260	88 %	60 %
7LG33-3AA0	315	330	82 %	55 %
7LG34-1AA0	400	410	82 %	55 %
7LG34-7AA0	450	465	87 %	55 %
7LG35-8AA0	560	575	85 %	50 %
7LG37-4AA0	710	735	79 %	55 %
7LG38-1AA0	800	810	95 %	55 %
7LG38-8AA0	900	910	87 %	55 %
7LG41-0AA0	1000	1025	86 %	50 %
7LG41-3AA0	1200	1270	79 %	40 %

For pulse frequencies in the range between the fixed values, the relevant derating factors can be determined by means of linear interpolation.

$$Y_2 = Y_0 + \frac{Y_1 - Y_0}{X_1 - X_0} (X_2 - X_0)$$

The following formula applies for this:

Example:

The derating factor is required for when $X_2 = 2 \text{ kHz}$ for 6SL3710-7LE41-0AA0.

$X_0 = 1.25 \text{ kHz}$, $Y_0 = 100\%$, $X_1 = 2.5 \text{ kHz}$, $Y_1 = 87\%$, $X_2 = 2 \text{ kHz}$, $Y_2 = ??$

$$Y_2 = 100 \% + \frac{87 \% - 100 \%}{2.5 \text{ kHz} - 1.25 \text{ kHz}} (2 \text{ kHz} - 1.25 \text{ kHz}) =$$

$$100 \% + \frac{-13 \%}{1.25 \text{ kHz}} (0.75 \text{ kHz}) = 100 \% - 7.8 \% = \underline{\underline{92.2 \%}}$$

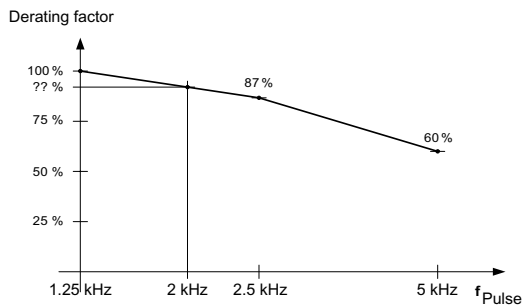


Figure 12-1 Calculating derating factors by means of linear interpolation

12.2.2 Overload capability

The converter is equipped with an overload reserve to deal with breakaway torques, for example.

In drives with overload requirements, the appropriate base load current must, therefore, be used as a basis for the required load.

The criterion for overload is that the drive is operated with its base load current before and after the overload occurs on the basis of a duty cycle duration of 300 s.

Low overload

The base load current for low overload (I_L) is based on a load duty cycle of 110% for 60 s or 150% for 10 s.

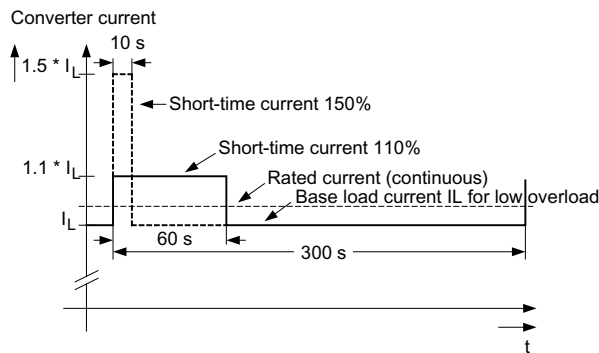


Figure 12-2 Low overload

High overload

The base load current for a high overload I_H is based on a duty cycle of 150% for 60 s or 160% for 10 s.

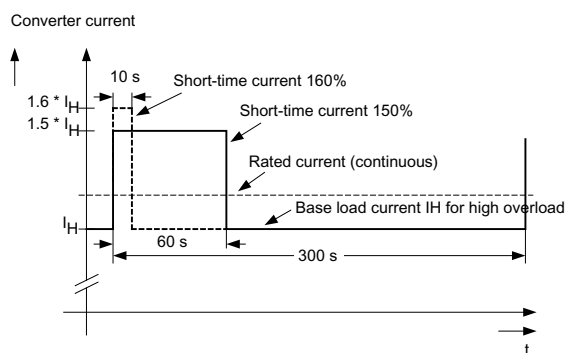


Figure 12-3 High overload

12.3 Technical specifications

Note

The current, voltage and output values specified in the following tables are rated values. The cables to the cabinet unit are protected by fuses with gL characteristic. The connection cross-sections are calculated for three-core copper cables installed horizontally in free air at an ambient temperature of 30 °C (86 °F) (in accordance with DIN VDE 0298 Part 2 / Group 5) and the recommended line protection in accordance with DIN VDE 0100 Part 430.

12.3.1 Cabinet unit version A, 380 V - 480 V 3 AC

Table 12- 8 Version A, 380 V – 480 V 3 AC, part 1

Order number	6SL3710	7LE32-1AA0	7LE32-6AA0	7LE33-1AA0
Unit rating - for I _L at 50 Hz 400 V ¹⁾ - for I _H at 50 Hz 400 V ¹⁾ - for I _L at 60 Hz 460 V ²⁾ - for I _H at 60 Hz 460 V ²⁾	kW kW hp hp	110 90 150 150	132 110 200 200	160 132 250 200
Output current - Rated current I _{NA} ³⁾ - Base load current I _L ⁴⁾ - Base load current I _H ⁵⁾ - Max. current I _{max A}	A A A A	210 205 178 307	260 250 233 375	310 302 277 453
Infeed/regenerative current - Rated current I _{NE} ⁶⁾ - Maximum current I _{max E}	A A	197 315	242 390	286 467
Max. current requirement - Auxiliary 24 V DC supply	A	Internal	Internal	Internal
Connection voltages - Line voltage - Line frequency - Electronics power supply	V _{ACrms} Hz V _{DC}	380 V 3 AC -10 % to 480 V 3 AC +10 % (-15 % < 1 min) 47 to 63 Hz 24 (20.4 - 28.8)		
Power loss	kW	6.31	7.55	10.01
Cooling air requirement	m ³ /s	0.58	0.70	1.19
Sound pressure level L_{pA} (1 m) at 50/60 Hz	dB(A)	71/73	71/73	72/74
Line connection - recommended: DIN VDE ⁷⁾ - maximum: DIN VDE - Fixing screw	mm ² mm ²	2 x 70 4 x 240 M12 (2 holes)	2 x 95 4 x 240 M12 (2 holes)	2 x 120 4 x 240 M12 (2 holes)
Motor connection - recommended: DIN VDE ⁷⁾ - maximum: DIN VDE - Fixing screw	mm ² mm ²	2 x 70 2 x 150 M12 (2 holes)	2 x 95 2 x 150 M12 (2 holes)	2 x 120 2 x 150 M12 (2 holes)
Protective conductor connection Fixing screw		M12 (2 holes)	M12 (2 holes)	M12 (2 holes)
Max. motor cable length shielded / unshielded	m	300 / 450	300 / 450	300 / 450
Dimensions (standard version) - Width - Height - Depth	mm mm mm	1400 2000 600	1400 2000 600	1600 2000 600
Frame sizes - Active Interface Module - Active Line Module - Motor Module		FI FX FX	FI FX FX	GI GX GX
Weight (without options), approx.	kg	708	708	892

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Order number	6SL3710	7LE32-1AA0	7LE32-6AA0	7LE33-1AA0
Recommended protection - Line protection (with option L26) Rated current frame size to DIN 43620-1	A	3NA3252 315 2	3NA3254 355 2	3NA3365 500 3
- Line and semiconductor protection (without option L26) Rated current Frame size to DIN 43620-1	A	3NE1230-2 315 1	3NE1331-2 350 2	3NE1334-2 500 2
<p>1) Rated output of a typical 6-pole standard induction motor based on I_L or I_H at 400 V 3 AC 50 Hz.</p> <p>2) Rated output of a typical 6-pole standard induction motor based on I_L or I_H at 460 V 3 AC 60 Hz.</p> <p>3) The currents are based on a line power factor $\cos \varphi = 1$.</p> <p>4) The base-load current I_L is based on a duty cycle of 110% for 60 s or 150% for 10 s with a duty cycle duration of 300 s (see "Overload capability").</p> <p>5) The base-load current I_H is based on a duty cycle of 150% for 60 s or 160% for 10 s with a duty cycle duration of 300 s (see "Overload capability").</p> <p>6) The current values given here are based on the rated output current.</p> <p>7) The recommendations for the North American market in AWG or MCM must be taken from the appropriate NEC (National Electrical Code) or CEC (Canadian Electrical Code) standards.</p>				

Table 12- 9 Version A, 380 V – 480 V 3 AC, part 2

Order number	6SL3710	7LE33-8AA0	7LE35-0AA0	7LE36-1AA0
Unit rating - for I _L at 50 Hz 400 V ¹⁾ - for I _H at 50 Hz 400 V ¹⁾ - for I _L at 60 Hz 460 V ²⁾ - for I _H at 60 Hz 460 V ²⁾	kW kW hp hp	200 160 300 250	250 200 400 350	315 250 500 350
Output current - Rated current I _{NA} ³⁾ - Base load current I _L ⁴⁾ - Base load current I _H ⁵⁾ - Max. current I _{max A}	A A A A	380 370 340 555	490 477 438 715	605 590 460 885
Infeed/regenerative current - Rated current I _{NE} ⁶⁾ - Maximum current I _{max E}	A A	349 570	447 735	549 907
Max. current requirement - Auxiliary 24 V DC supply	A	Internal	Internal	Internal
Connection voltages - Line voltage - Line frequency - Electronics power supply	V _{ACrms} Hz V _{DC}	380 V 3 AC -10 % to 480 V 3 AC +10 % (-15 % < 1 min) 47 to 63 Hz 24 (20.4 - 28.8)		
Power loss	kW	10.72	13.13	17.69
Cooling air requirement	m ³ /s	1.19	1.19	1.96
Sound pressure level L_{pA} (1 m) at 50/60 Hz	dB(A)	72/74	72/74	77/79
Line connection - recommended: DIN VDE ⁷⁾ - maximum: DIN VDE - Fixing screw	mm ² mm ²	2 x 120 4 x 240 M12 (2 holes)	2 x 240 4 x 240 M12 (2 holes)	2 x 240 4 x 240 M12 (2 holes)
Motor connection - recommended: DIN VDE ⁷⁾ - maximum: DIN VDE - Fixing screw	mm ² mm ²	2 x 120 2 x 150 M12 (2 holes)	2 x 185 2 x 240 M12 (2 holes)	2 x 240 4 x 240 M12 (2 holes)
Protective conductor connection Fixing screw		M12 (2 holes)	M12 (2 holes)	M12 (2 holes)
Max. motor cable length shielded / unshielded	m	300 / 450	300 / 450	300 / 450
Dimensions (standard version) - Width - Height - Depth	mm mm mm	1800 2000 600	1800 2000 600	2200 2000 600
Frame sizes - Active Interface Module - Active Line Module - Motor Module		GI GX GX	GI GX GX	HI HX HX
Weight (without options), approx.	kg	980	980	1716

12.3 Technical specifications

Order number	6SL3710	7LE33-8AA0	7LE35-0AA0	7LE36-1AA0
Recommended protection - Line protection (with option L26) Rated current frame size to DIN 43620-1	A	3NA3365 500 3	3NA3372 630 3	3NA3475 800 4
- Line and semiconductor protection (without option L26) Rated current Frame size to DIN 43620-1	A	3NE1334-2 500 2	3NE1436-2 630 3	3NE1438-2 800 3
<p>1) Rated output of a typical 6-pole standard induction motor based on I_L or I_H at 400 V 3 AC 50 Hz.</p> <p>2) Rated output of a typical 6-pole standard induction motor based on I_L or I_H at 460 V 3 AC 60 Hz.</p> <p>3) The currents are based on a line power factor $\cos \varphi = 1$.</p> <p>4) The base-load current I_L is based on a duty cycle of 110% for 60 s or 150% for 10 s with a duty cycle duration of 300 s (see "Overload capability").</p> <p>5) The base-load current I_H is based on a duty cycle of 150% for 60 s or 160% for 10 s with a duty cycle duration of 300 s (see "Overload capability").</p> <p>6) The current values given here are based on the rated output current.</p> <p>7) The recommendations for the North American market in AWG or MCM must be taken from the appropriate NEC (National Electrical Code) or CEC (Canadian Electrical Code) standards.</p>				

Table 12- 10 Version A, 380 V – 480 V 3 AC, part 3

Order number	6SL3710	7LE37-5AA0	7LE38-4AA0	7LE41-0AA0
Unit rating - for I _L at 50 Hz 400 V ¹⁾ - for I _H at 50 Hz 400 V ¹⁾ - for I _L at 60 Hz 460 V ²⁾ - for I _H at 60 Hz 460 V ²⁾	kW kW hp hp	400 315 600 450	450 400 700 600	560 450 800 700
Output current - Rated current I _{NA} ³⁾ - Base load current I _L ⁴⁾ - Base load current I _H ⁵⁾ - Max. current I _{max A}	A A A A	745 725 570 1087	840 820 700 1230	985 960 860 1440
Infeed/regenerative current - Rated current I _{NE} ⁶⁾ - Maximum current I _{max E}	A A	674 1118	759 1260	888 1477
Max. current requirement - Auxiliary 24 V DC supply	A	Internal	Internal	Internal
Connection voltages - Line voltage - Line frequency - Electronics power supply	V _{ACrms} Hz V _{DC}	380 V 3 AC -10 % to 480 V 3 AC +10 % (-15 % < 1 min) 47 to 63 Hz 24 (20.4 - 28.8)		
Power loss	kW	20.63	21.1	27.25
Cooling air requirement	m ³ /s	1.96	1.96	2.6
Sound pressure level L_{pA} (1 m) at 50/60 Hz	dB(A)	77/79	77/79	77/79
Line connection - recommended: DIN VDE ⁷⁾ - maximum: DIN VDE - Fixing screw	mm ² mm ²	2 x 300 4 x 240 M12 (2 holes)	4 x 150 8 x 240 M12 (4 holes)	4 x 185 8 x 240 M12 (4 holes)
Motor connection - recommended: DIN VDE ⁷⁾ - maximum: DIN VDE - Fixing screw	mm ² mm ²	2 x 300 4 x 240 M12 (2 holes)	4 x 150 4 x 240 M12 (2 holes)	4 x 185 6 x 240 M12 (3 holes)
Protective conductor connection Fixing screw		M12 (10 holes)	M12 (16 holes)	M12 (18 holes)
Max. motor cable length shielded / unshielded	m	300 / 450	300 / 450	300 / 450
Dimensions (standard version) - Width - Height - Depth	mm mm mm	2200 2000 600	2200 2000 600	2800 2000 600
Frame sizes - Active Interface Module - Active Line Module - Motor Module		HI HX HX	HI HX HX	JI JX JX
Weight (without options), approx.	kg	1731	1778	2408

12.3 Technical specifications

Order number	6SL3710	7LE37-5AA0	7LE38-4AA0	7LE41-0AA0
Recommended protection				
- Line protection (with option L26) Rated current frame size to DIN 43620-1	A	3NA3475 800 4	Circuit breaker	Circuit breaker
- Line and semiconductor protection (without option L26) Rated current Frame size to DIN 43620-1	A	3NE1448-2 850 3	Circuit breaker	Circuit breaker
<p>1) Rated output of a typical 6-pole standard induction motor based on I_L or I_H at 400 V 3 AC 50 Hz.</p> <p>2) Rated output of a typical 6-pole standard induction motor based on I_L or I_H at 460 V 3 AC 60 Hz.</p> <p>3) The currents are based on a line power factor $\cos \varphi = 1$.</p> <p>4) The base-load current I_L is based on a duty cycle of 110% for 60 s or 150% for 10 s with a duty cycle duration of 300 s (see "Overload capability").</p> <p>5) The base-load current I_H is based on a duty cycle of 150% for 60 s or 160% for 10 s with a duty cycle duration of 300 s (see "Overload capability").</p> <p>6) The current values given here are based on the rated output current.</p> <p>7) The recommendations for the North American market in AWG or MCM must be taken from the appropriate NEC (National Electrical Code) or CEC (Canadian Electrical Code) standards.</p>				

Table 12- 11 Version A, 380 V – 480 V 3 AC, part 4

Order number	6SL3710	7LE41-2AA0	7LE41-4AA0	
Unit rating - for I _L at 50 Hz 400 V ¹⁾ - for I _H at 50 Hz 400 V ¹⁾ - for I _L at 60 Hz 460 V ²⁾ - for I _H at 60 Hz 460 V ²⁾	kW kW hp hp	710 560 1000 900	800 710 1000 1000	
Output current - Rated current I _{NA} ³⁾ - Base load current I _L ⁴⁾ - Base load current I _H ⁵⁾ - Max. current I _{max A}	A A A A	1260 1230 1127 1845	1405 1370 1257 2055	
Infeed/regenerative current - Rated current I _{NE} ⁶⁾ - Maximum current I _{max E}	A A	1133 1891	1262 2107	
Max. current requirement - Auxiliary 24 V DC supply	A	Internal	Internal	
Connection voltages - Line voltage - Line frequency - Electronics power supply	V _{ACrms} Hz V _{DC}	380 V 3 AC -10 % to 480 V 3 AC +10 % (-15 % < 1 min) 47 to 63 Hz 24 (20.4 - 28.8)		
Power loss	kW	33.05	33.95	
Cooling air requirement	m ³ /s	2.6	2.6	
Sound pressure level L_{pA} (1 m) at 50/60 Hz	dB(A)	78/80	78/80	
Line connection - recommended: DIN VDE ⁷⁾ - maximum: DIN VDE - Fixing screw	mm ² mm ²	4 x 240 8 x 240 M12 (4 holes)	6 x 185 8 x 240 M12 (4 holes)	
Motor connection - recommended: DIN VDE ⁷⁾ - maximum: DIN VDE - Fixing screw	mm ² mm ²	4 x 240 6 x 240 M12 (3 holes)	6 x 185 6 x 240 M12 (3 holes)	
Protective conductor connection Fixing screw		M12 (18 holes)	M12 (18 holes)	
Max. motor cable length shielded / unshielded	m	300 / 450	300 / 450	
Dimensions (standard version) - Width - Height - Depth	mm mm mm	2800 2000 600	2800 2000 600	
Frame sizes - Active Interface Module - Active Line Module - Motor Module		J1 JX JX	J1 JX JX	
Weight (without options), approx.	kg	2408	2408	

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Order number	6SL3710	7LE41-2AA0	7LE41-4AA0	
Recommended protection				
- Line protection (with option L26) Rated current frame size to DIN 43620-1	A	Circuit breaker	Circuit breaker	
- Line and semiconductor protection (without option L26) Rated current Frame size to DIN 43620-1	A	Circuit breaker	Circuit breaker	
<p>1) Rated output of a typical 6-pole standard induction motor based on I_L or I_H at 400 V 3 AC 50 Hz.</p> <p>2) Rated output of a typical 6-pole standard induction motor based on I_L or I_H at 460 V 3 AC 60 Hz.</p> <p>3) The currents are based on a line power factor $\cos \phi = 1$.</p> <p>4) The base-load current I_L is based on a duty cycle of 110% for 60 s or 150% for 10 s with a duty cycle duration of 300 s (see "Overload capability").</p> <p>5) The base-load current I_H is based on a duty cycle of 150% for 60 s or 160% for 10 s with a duty cycle duration of 300 s (see "Overload capability").</p> <p>6) The current values given here are based on the rated output current.</p> <p>7) The recommendations for the North American market in AWG or MCM must be taken from the appropriate NEC (National Electrical Code) or CEC (Canadian Electrical Code) standards.</p>				

12.3.2 Cabinet unit version A, 500 V - 690 V 3 AC

Table 12- 12 Version A, 500 V – 690 V 3 AC, part 1

Order number	6SL3710	7LG28-5AA0	7LG31-0AA0	7LG31-2AA0
Unit rating				
- for I _L at 50 Hz 690 V ¹⁾	kW	75	90	110
- for I _H at 50 Hz 690 V ¹⁾	kW	55	75	90
- for I _L at 50 Hz 500 V ¹⁾	kW	55	55	75
- for I _H at 50 Hz 500 V ¹⁾	kW	45	55	75
- for I _L at 60 Hz 575 V ²⁾	hp	75	75	100
- for I _H at 60 Hz 575 V ²⁾	hp	75	75	100
Output current				
- Rated current I _{NA} ³⁾	A	85	100	120
- Base load current I _L ⁴⁾	A	80	95	115
- Base load current I _H ⁵⁾	A	76	89	107
- Max. current I _{max A}	A	120	142	172
Infeed/regenerative current				
- Rated current I _{NE} ⁶⁾	A	86	99	117
- Maximum current I _{max E}	A	125	144	170
Max. current requirement				
- Auxiliary 24 V DC supply	A	Internal	Internal	Internal
Connection voltages		500 V 3 AC -10 % to 690 V 3 AC +10 % (-15 % < 1 min) 47 to 63 Hz 24 (20.4 - 28.8)		
- Line voltage	V _{ACrms}			
- Line frequency	Hz			
- Electronics power supply	V _{DC}			
Power loss	kW	5.12	5.38	5.84
Cooling air requirement	m ³ /s	0.58	0.58	0.58
Sound pressure level L_{pA} (1 m) at 50/60 Hz	dB(A)	71/73	71/73	71/73
Line connection				
- recommended: DIN VDE ⁷⁾	mm ²	50	50	70
- maximum: DIN VDE	mm ²	4 x 240	4 x 240	4 x 240
- Fixing screw		M12 (2 holes)	M12 (2 holes)	M12 (2 holes)
Motor connection				
- recommended: DIN VDE ⁷⁾	mm ²	50	50	70
- maximum: DIN VDE	mm ²	2 x 70	2 x 150	2 x 150
- Fixing screw		M12 (2 holes)	M12 (2 holes)	M12 (2 holes)
Protective conductor connection				
Fixing screw		M12 (2 holes)	M12 (2 holes)	M12 (2 holes)
Max. motor cable length shielded / unshielded	m	300 / 450	300 / 450	300 / 450
Dimensions (standard version)				
- Width	mm	1400	1400	1400
- Height	mm	2000	2000	2000
- Depth	mm	600	600	600
Frame sizes				
- Active Interface Module		FI	FI	FI
- Active Line Module		FX	FX	FX
- Motor Module		FX	FX	FX
Weight (without options), approx.	kg	708	708	708

12.3 Technical specifications

Order number	6SL3710	7LG28-5AA0	7LG31-0AA0	7LG31-2AA0
Recommended protection				
- Line protection (with option L26)				
Rated current	A	3NA3132-6	3NA3132-6	3NA3136-6
frame size to DIN 43620-1		125	125	160
- Line and semiconductor protection (without option L26)		1	1	1
Rated current	A	3NE1022-2	3NE1022-2	3NE1224-2
Frame size to DIN 43620-1		125	125	160
		00	00	1
<p>1) Rated output of a typical 6-pole standard induction motor based on I_L or I_H at 500 V 3 AC 50 Hz or 690 V 3 AC 50 Hz.</p> <p>2) Rated output of a typical 6-pole standard induction motor based on I_L or I_H at 575 V 3 AC 60 Hz.</p> <p>3) The currents are based on a line power factor $\cos \varphi = 1$.</p> <p>4) The base-load current I_L is based on a duty cycle of 110% for 60 s or 150% for 10 s with a duty cycle duration of 300 s (see "Overload capability").</p> <p>5) The base-load current I_H is based on a duty cycle of 150% for 60 s or 160% for 10 s with a duty cycle duration of 300 s (see "Overload capability").</p> <p>6) The current values given here are based on the rated output current.</p> <p>7) The recommendations for the North American market in AWG or MCM must be taken from the appropriate NEC (National Electrical Code) or CEC (Canadian Electrical Code) standards.</p>				

Table 12- 13 Version A, 500 V – 690 V 3 AC, part 2

Order number	6SL3710	7LG31-5AA0	7LG31-8AA0	7LG32-2AA0
Unit rating - for I _L at 50 Hz 690 V ¹⁾ - for I _H at 50 Hz 690 V ¹⁾ - for I _L at 50 Hz 500 V ¹⁾ - for I _H at 50 Hz 500 V ¹⁾ - for I _L at 60 Hz 575 V ²⁾ - for I _H at 60 Hz 575 V ²⁾	kW kW kW kW hp hp	132 110 90 90 150 125	160 132 110 90 150 150	200 160 132 110 200 200
Output current - Rated current I _{NA} ³⁾ - Base load current I _L ⁴⁾ - Base load current I _H ⁵⁾ - Max. current I _{max A}	A A A A	150 142 134 213	175 170 157 255	215 208 192 312
Infeed/regenerative current - Rated current I _{NE} ⁶⁾ - Maximum current I _{max E}	A A	144 210	166 253	202 308
Max. current requirement - Auxiliary 24 V DC supply	A	Internal	Internal	Internal
Connection voltages - Line voltage - Line frequency - Electronics power supply	V _{ACrms} Hz V _{DC}	500 V 3 AC -10 % to 690 V 3 AC +10 % (-15 % < 1 min) 47 to 63 Hz 24 (20.4 - 28.8)		
Power loss	kW	5.75	11.02	11.44
Cooling air requirement	m ³ /s	0.58	1.19	1.19
Sound pressure level L_{pA} (1 m) at 50/60 Hz	dB(A)	71/73	75/77	75/77
Line connection - recommended: DIN VDE ⁷⁾ - maximum: DIN VDE - Fixing screw	mm ² mm ²	95 4 x 240 M12 (2 holes)	120 4 x 240 M12 (2 holes)	2 x 70 4 x 240 M12 (2 holes)
Motor connection - recommended: DIN VDE ⁷⁾ - maximum: DIN VDE - Fixing screw	mm ² mm ²	95 2 x 150 M12 (2 holes)	120 2 x 150 M12 (2 holes)	2 x 70 2 x 150 M12 (2 holes)
Protective conductor connection Fixing screw		M12 (2 holes)	M12 (2 holes)	M12 (2 holes)
Max. motor cable length shielded / unshielded	m	300 / 450	300 / 450	300 / 450
Dimensions (standard version) - Width - Height - Depth	mm mm mm	1400 2000 600	1600 2000 600	1600 2000 600
Frame sizes - Active Interface Module - Active Line Module - Motor Module		FI FX FX	GI GX GX	GI GX GX
Weight (without options), approx.	kg	708	892	892

12.3 Technical specifications

Order number	6SL3710	7LG31-5AA0	7LG31-8AA0	7LG32-2AA0
Recommended protection				
- Line protection (with option L26)				
Rated current	A	3NA3240-6	3NA3244-6	3NA3252-6
frame size to DIN 43620-1		200	250	315
- Line and semiconductor protection (without option L26)		2	2	2
Rated current	A	3NE1225-2	3NE1227-2	3NE1230-2
Frame size to DIN 43620-1		200	250	315
		1	1	1
<p>1) Rated output of a typical 6-pole standard induction motor based on I_L or I_H at 500 V 3 AC 50 Hz or 690 V 3 AC 50 Hz.</p> <p>2) Rated output of a typical 6-pole standard induction motor based on I_L or I_H at 575 V 3 AC 60 Hz.</p> <p>3) The currents are based on a line power factor $\cos \varphi = 1$.</p> <p>4) The base-load current I_L is based on a duty cycle of 110% for 60 s or 150% for 10 s with a duty cycle duration of 300 s (see "Overload capability").</p> <p>5) The base-load current I_H is based on a duty cycle of 150% for 60 s or 160% for 10 s with a duty cycle duration of 300 s (see "Overload capability").</p> <p>6) The current values given here are based on the rated output current.</p> <p>7) The recommendations for the North American market in AWG or MCM must be taken from the appropriate NEC (National Electrical Code) or CEC (Canadian Electrical Code) standards.</p>				

Table 12- 14 Version A, 500 V – 690 V 3 AC, part 3

Order number	6SL3710	7LG32-6AA0	7LG33-3AA0	7LG34-1AA0
Unit rating - for I _L at 50 Hz 690 V ¹⁾ - for I _H at 50 Hz 690 V ¹⁾ - for I _L at 50 Hz 500 V ¹⁾ - for I _H at 50 Hz 500 V ¹⁾ - for I _L at 60 Hz 575 V ²⁾ - for I _H at 60 Hz 575 V ²⁾	kW kW kW kW hp hp	250 200 160 132 250 200	315 250 200 160 300 250	400 315 250 200 400 350
Output current - Rated current I _{NA} ³⁾ - Base load current I _L ⁴⁾ - Base load current I _H ⁵⁾ - Max. current I _{max A}	A A A A	260 250 233 375	330 320 280 480	410 400 367 600
Infeed/regenerative current - Rated current I _{NE} ⁶⁾ - Maximum current I _{max E}	A A	242 370	304 465	375 619
Max. current requirement - Auxiliary 24 V DC supply	A	Internal	Internal	Internal
Connection voltages - Line voltage - Line frequency - Electronics power supply	V _{ACrms} Hz V _{DC}	500 V 3 AC -10 % to 690 V 3 AC +10 % (-15 % < 1 min) 47 to 63 Hz 24 (20.4 - 28.8)		
Power loss	kW	11.97	12.69	19.88
Cooling air requirement	m ³ /s	1.19	1.19	1.96
Sound pressure level L_{pA} (1 m) at 50/60 Hz	dB(A)	75/77	75/77	77/79
Line connection - recommended: DIN VDE ⁷⁾ - maximum: DIN VDE - Fixing screw	mm ² mm ²	2 x 95 4 x 240 M12 (2 holes)	2 x 120 4 x 240 M12 (2 holes)	2 x 185 4 x 240 M12 (2 holes)
Motor connection - recommended: DIN VDE ⁷⁾ - maximum: DIN VDE - Fixing screw	mm ² mm ²	2 x 95 2 x 185 M12 (2 holes)	2 x 120 2 x 240 M12 (2 holes)	2 x 185 4 x 240 M12 (2 holes)
Protective conductor connection Fixing screw		M12 (2 holes)	M12 (2 holes)	M12 (2 holes)
Max. motor cable length shielded / unshielded	m	300 / 450	300 / 450	300 / 450
Dimensions (standard version) - Width - Height - Depth	mm mm mm	1600 2000 600	1600 2000 600	2200 2000 600
Frame sizes - Active Interface Module - Active Line Module - Motor Module		GI GX GX	GI GX GX	HI HX HX
Weight (without options), approx.	kg	892	892	1716

12.3 Technical specifications

Order number	6SL3710	7LG32-6AA0	7LG33-3AA0	7LG34-1AA0
Recommended protection				
- Line protection (with option L26)				
Rated current	A	3NA3354-6	3NA3365-6	3NA3365-6
frame size to DIN 43620-1		355	500	500
- Line and semiconductor protection (without option L26)		3	3	3
Rated current	A	3NE1331-2	3NE1334-2	3NE1334-2
Frame size to DIN 43620-1		350	500	500
		2	2	2
<p>1) Rated output of a typical 6-pole standard induction motor based on I_L or I_H at 500 V 3 AC 50 Hz or 690 V 3 AC 50 Hz.</p> <p>2) Rated output of a typical 6-pole standard induction motor based on I_L or I_H at 575 V 3 AC 60 Hz.</p> <p>3) The currents are based on a line power factor $\cos \varphi = 1$.</p> <p>4) The base-load current I_L is based on a duty cycle of 110% for 60 s or 150% for 10 s with a duty cycle duration of 300 s (see "Overload capability").</p> <p>5) The base-load current I_H is based on a duty cycle of 150% for 60 s or 160% for 10 s with a duty cycle duration of 300 s (see "Overload capability").</p> <p>6) The current values given here are based on the rated output current.</p> <p>7) The recommendations for the North American market in AWG or MCM must be taken from the appropriate NEC (National Electrical Code) or CEC (Canadian Electrical Code) standards.</p>				

Table 12- 15 Version A, 500 V – 690 V 3 AC, part 4

Order number	6SL3710	7LG34-7AA0	7LG35-8AA0	7LG37-4AA0
Unit rating - for I _L at 50 Hz 690 V ¹⁾ - for I _H at 50 Hz 690 V ¹⁾ - for I _L at 50 Hz 500 V ¹⁾ - for I _H at 50 Hz 500 V ¹⁾ - for I _L at 60 Hz 575 V ²⁾ - for I _H at 60 Hz 575 V ²⁾	kW kW kW kW hp hp	450 400 315 250 450 450	560 450 400 315 600 500	710 630 500 450 700 700
Output current - Rated current I _{NA} ³⁾ - Base load current I _L ⁴⁾ - Base load current I _H ⁵⁾ - Max. current I _{max A}	A A A A	465 452 416 678	575 560 514 840	735 710 657 1065
Infeed/regenerative current - Rated current I _{NE} ⁶⁾ - Maximum current I _{max E}	A A	424 700	522 862	665 1102
Max. current requirement - Auxiliary 24 V DC supply	A	Internal	Internal	Internal
Connection voltages - Line voltage - Line frequency - Electronics power supply	V _{ACrms} Hz V _{DC}	500 V 3 AC -10 % to 690 V 3 AC +10 % (-15 % < 1 min) 47 to 63 Hz 24 (20.4 - 28.8)		
Power loss	kW	20.55	24.05	30.25
Cooling air requirement	m ³ /s	1.96	1.96	2.6
Sound pressure level L_{pA} (1 m) at 50/60 Hz	dB(A)	77/79	77/79	77/79
Line connection - recommended: DIN VDE ⁷⁾ - maximum: DIN VDE - Fixing screw	mm ² mm ²	2 x 185 4 x 240 M12 (2 holes)	2 x 240 4 x 240 M12 (2 holes)	3 x 185 8 x 240 M12 (4 holes)
Motor connection - recommended: DIN VDE ⁷⁾ - maximum: DIN VDE - Fixing screw	mm ² mm ²	2 x 185 4 x 240 M12 (2 holes)	2 x 240 4 x 240 M12 (2 holes)	3 x 185 6 x 240 M12 (3 holes)
Protective conductor connection Fixing screw		M12 (2 holes)	M12 (2 holes)	M12 (18 holes)
Max. motor cable length shielded / unshielded	m	300 / 450	300 / 450	300 / 450
Dimensions (standard version) - Width - Height - Depth	mm mm mm	2200 2000 600	2200 2000 600	2800 2000 600
Frame sizes - Active Interface Module - Active Line Module - Motor Module		HI HX HX	HI HX HX	JI JX JX
Weight (without options), approx.	kg	1716	1716	2300

12.3 Technical specifications

Order number	6SL3710	7LG34-7AA0	7LG35-8AA0	7LG37-4AA0
Recommended protection - Line protection (with option L26) Rated current frame size to DIN 43620-1	A	3NA3352-6 2 x 315 2	3NA3354-6 2 x 355 3	3NA3365-6 2 x 500 3
- Line and semiconductor protection (without option L26) Rated current Frame size to DIN 43620-1	A	3NE1435-2 560 3	3NE1447-2 670 3	3NE1448-2 850 3
<p>¹⁾ Rated output of a typical 6-pole standard induction motor based on I_L or I_H at 500 V 3 AC 50 Hz or 690 V 3 AC 50 Hz.</p> <p>²⁾ Rated output of a typical 6-pole standard induction motor based on I_L or I_H at 575 V 3 AC 60 Hz.</p> <p>³⁾ The currents are based on a line power factor cos φ = 1.</p> <p>⁴⁾ The base-load current I_L is based on a duty cycle of 110% for 60 s or 150% for 10 s with a duty cycle duration of 300 s (see "Overload capability").</p> <p>⁵⁾ The base-load current I_H is based on a duty cycle of 150% for 60 s or 160% for 10 s with a duty cycle duration of 300 s (see "Overload capability").</p> <p>⁶⁾ The current values given here are based on the rated output current.</p> <p>⁷⁾ The recommendations for the North American market in AWG or MCM must be taken from the appropriate NEC (National Electrical Code) or CEC (Canadian Electrical Code) standards.</p>				

Table 12- 16 Version A, 500 V – 690 V 3 AC, part 5

Order number	6SL3710	7LG38-1AA0	7LG38-8AA0	7LG41-0AA0
Unit rating - for I _L at 50 Hz 690 V ¹⁾ - for I _H at 50 Hz 690 V ¹⁾ - for I _L at 50 Hz 500 V ¹⁾ - for I _H at 50 Hz 500 V ¹⁾ - for I _L at 60 Hz 575 V ²⁾ - for I _H at 60 Hz 575 V ²⁾	kW kW kW kW hp hp	800 710 560 500 800 700	900 800 630 560 900 800	1000 900 710 630 1000 900
Output current - Rated current I _{NA} ³⁾ - Base load current I _L ⁴⁾ - Base load current I _H ⁵⁾ - Max. current I _{max A}	A A A A	810 790 724 1185	910 880 814 1320	1025 1000 917 1500
Infeed/regenerative current - Rated current I _{NE} ⁶⁾ - Maximum current I _{max E}	A A	732 1218	821 1367	923 1537
Max. current requirement - Auxiliary 24 V DC supply	A	Internal	Internal	Internal
Connection voltages - Line voltage - Line frequency - Electronics power supply	V _{ACrms} Hz V _{DC}	500 V 3 AC -10 % to 690 V 3 AC +10 % (-15 % < 1 min) 47 to 63 Hz 24 (20.4 - 28.8)		
Power loss	kW	34.45	34.65	36.15
Cooling air requirement	m ³ /s	2.6	2.6	2.6
Sound pressure level L_{pA} (1 m) at 50/60 Hz	dB(A)	77/79	77/79	77/79
Line connection - recommended: DIN VDE ⁷⁾ - maximum: DIN VDE - Fixing screw	mm ² mm ²	4 x 150 8 x 240 M12 (4 holes)	4 x 150 8 x 240 M12 (4 holes)	4 x 185 8 x 240 M12 (4 holes)
Motor connection - recommended: DIN VDE ⁷⁾ - maximum: DIN VDE - Fixing screw	mm ² mm ²	4 x 150 6 x 240 M12 (3 holes)	4 x 150 6 x 240 M12 (3 holes)	4 x 185 6 x 240 M12 (3 holes)
Protective conductor connection Fixing screw		M12 (18 holes)	M12 (18 holes)	M12 (18 holes)
Max. motor cable length shielded / unshielded	m	300 / 450	300 / 450	300 / 450
Dimensions (standard version) - Width - Height - Depth	mm mm mm	2800 2000 600	2800 2000 600	2800 2000 600
Frame sizes - Active Interface Module - Active Line Module - Motor Module		J1 JX JX	J1 JX JX	J1 JX JX
Weight (without options), approx.	kg	2408	2408	2408

12.3 Technical specifications

Order number	6SL3710	7LG38-1AA0	7LG38-8AA0	7LG41-0AA0
Recommended protection - Line protection (with option L26) Rated current frame size to DIN 43620-1	A	Circuit breaker	Circuit breaker	Circuit breaker
- Line and semiconductor protection (without option L26) Rated current Frame size to DIN 43620-1	A	Circuit breaker	Circuit breaker	Circuit breaker
1) Rated output of a typical 6-pole standard induction motor based on I_L or I_H at 500 V 3 AC 50 Hz or 690 V 3 AC 50 Hz. 2) Rated output of a typical 6-pole standard induction motor based on I_L or I_H at 575 V 3 AC 60 Hz. 3) The currents are based on a line power factor $\cos \phi = 1$. 4) The base-load current I_L is based on a duty cycle of 110% for 60 s or 150% for 10 s with a duty cycle duration of 300 s (see "Overload capability"). 5) The base-load current I_H is based on a duty cycle of 150% for 60 s or 160% for 10 s with a duty cycle duration of 300 s (see "Overload capability"). 6) The current values given here are based on the rated output current. 7) The recommendations for the North American market in AWG or MCM must be taken from the appropriate NEC (National Electrical Code) or CEC (Canadian Electrical Code) standards.				

Table 12- 17 Version A, 500 V – 690 V 3 AC, part 6

Order number	6SL3710	7LG41-3AA0		
Unit rating - for I _L at 50 Hz 690 V ¹⁾ - for I _H at 50 Hz 690 V ¹⁾ - for I _L at 50 Hz 500 V ¹⁾ - for I _H at 50 Hz 500 V ¹⁾ - for I _L at 60 Hz 575 V ²⁾ - for I _H at 60 Hz 575 V ²⁾	kW kW kW kW hp hp	1200 1000 1250 800 1000 1000		
Output current - Rated current I _{NA} ³⁾ - Base load current I _L ⁴⁾ - Base load current I _H ⁵⁾ - Max. current I _{max A}	A A A A	1270 1230 1136 1845		
Infeed/regenerative current - Rated current I _{NE} ⁶⁾ - Maximum current I _{max E}	A A	1142 1905		
Max. current requirement - Auxiliary 24 V DC supply	A	Internal		
Connection voltages - Line voltage - Line frequency - Electronics power supply	V _{ACrms} Hz V _{DC}	500 V 3 AC -10 % to 690 V 3 AC +10 % (-15 % < 1 min) 47 to 63 Hz 24 (20.4 - 28.8)		
Power loss	kW	42.25		
Cooling air requirement	m ³ /s	2.6		
Sound pressure level L_{pA} (1 m) at 50/60 Hz	dB(A)	77/79		
Line connection - recommended: DIN VDE ⁷⁾ - maximum: DIN VDE - Fixing screw	mm ² mm ²	4 x 240 8 x 240 M12 (4 holes)		
Motor connection - recommended: DIN VDE ⁷⁾ - maximum: DIN VDE - Fixing screw	mm ² mm ²	4 x 240 6 x 240 M12 (3 holes)		
Protective conductor connection Fixing screw		M12 (18 holes)		
Max. motor cable length shielded / unshielded	m	300 / 450		
Dimensions (standard version) - Width - Height - Depth	mm mm mm	2800 2000 600		
Frame sizes - Active Interface Module - Active Line Module - Motor Module		J1 JX JX		
Weight (without options), approx.	kg	2408		

12.3 Technical specifications

Order number	6SL3710	7LG41-3AA0		
Recommended protection				
- Line protection (with option L26) Rated current frame size to DIN 43620-1	A	Circuit breaker		
- Line and semiconductor protection (without option L26) Rated current Frame size to DIN 43620-1	A	Circuit breaker		
<p>1) Rated output of a typical 6-pole standard induction motor based on I_L or I_H at 500 V 3 AC 50 Hz or 690 V 3 AC 50 Hz.</p> <p>2) Rated output of a typical 6-pole standard induction motor based on I_L or I_H at 575 V 3 AC 60 Hz.</p> <p>3) The currents are based on a line power factor $\cos \phi = 1$.</p> <p>4) The base-load current I_L is based on a duty cycle of 110% for 60 s or 150% for 10 s with a duty cycle duration of 300 s (see "Overload capability").</p> <p>5) The base-load current I_H is based on a duty cycle of 150% for 60 s or 160% for 10 s with a duty cycle duration of 300 s (see "Overload capability").</p> <p>6) The current values given here are based on the rated output current.</p> <p>7) The recommendations for the North American market in AWG or MCM must be taken from the appropriate NEC (National Electrical Code) or CEC (Canadian Electrical Code) standards.</p>				

Appendix

A.1 List of abbreviations

A	
A...	Alarm
AC	Alternating current
AI	Analog input
AO	Analog output
AOP	Advanced operator panel (with plain-text display)
B	
BI	Binector input
BICO	Binector/connector
BO	Binector output
C	
C	Capacitance
CAN	Serial bus system
CB	Communication board
CDS	Command data set
CI	Connector input
COM	Center contact on a changeover contact
CU	Control Unit
D	
DC	Direct current
DDS	Drive data set
DI	Digital input
DI/DO	Digital input/output bidirectional
DO	Digital output
E	
ESD	Electrostatic devices
EMC	Electromagnetic compatibility
EN	European standard
F	
F ...	Fault
FAQ	Frequently asked questions
FW	Firmware
H	
RFG	Ramp-function generator
HW	Hardware
I	

I/O	Input/output
IEC	International electrical engineering standard
IGBT	Insulated gate bipolar transistor
J	
JOG	Jog mode
L	
L	Inductance
LED	Light-emitting diode
M	
M	Ground
MDS	Motor data set
N	
NC	Normally closed contact
NEMA	Standardization body in the USA (United States of America)
NO	Normally open contact
P	
p ...	Adjustable parameter
PDS	Power unit data set
PE	Protective earth
PROFIBUS	Serial data bus
PTC	Positive temperature coefficient
R	
r...	Visualization parameter (read-only)
RAM	Read and write memory
RS 232	Serial interface
RS 485	Standard. Describes the physical characteristics of a digital serial interface.
S	
SI	Safety Integrated
STW	PROFIdrive control word
SW	Software
T	
TIA	Totally Integrated Automation
TM	Terminal Module
U	
UL	Underwriters Laboratories Inc.
V	
V _{dc}	DC link voltage
Z	
ZSW	PROFIdrive status word

A.2 Parameter macros

Parameter macro p0015 = S150 cabinet unit

This macro is used to make default settings for operating the cabinet unit.

Table A- 1 Parameter macro p0015 = S150 cabinet unit

Sink			Source		
Parameter	Description	DO	Parameter	Description	DO
p0500	Technology application	Vector	0	Standard drive	Vector
p0600	Motor temperature sensor for monitoring	Vector	0	No sensor	Vector
p0601	Motor temperature sensor type	Vector	0	No sensor	Vector
p0603	CI: Motor temperature	Vector	r4105	Sensor on TM31	TM31
p0604	Motor overtemperature alarm threshold	Vector	120	120 °C	Vector
p0605	Motor overtemperature fault threshold	Vector	155	155 °C	Vector
p0606	Motor overtemperature timer	Vector	0	0 s	Vector
p0610	Response to motor overtemperature condition	Vector	1	Display fault, for alarm I _{max} red.	Vector
p0700[0]	Macro binector input (BI)	Vector	70006	TM31 terminals	Vector
p0857	Power unit monitoring time	Vector	30000	30 s	Vector
p0864	BI: Infeed operation	Vector	r0863.0	Drive link - open-loop control	A_INF
p1000[0]	Macro connector inputs (CI) for speed setpoints	Vector	10002	TM31_AI0	Vector
p1001	CO: Fixed speed setpoint 1	Vector	300	300 rpm	Vector
p1002	CO: Fixed speed setpoint 2	Vector	600	600 rpm	Vector
p1003	CO: Fixed speed setpoint 3	Vector	1500	1500 rpm	Vector
p1083	CO: Speed limit in positive direction of rotation	Vector	6000	6000 rpm	Vector
p1086	CO: Speed limit in negative direction of rotation	Vector	-6000	-6000 rpm	Vector
p1115	Ramp-function generator selection	Vector	1	Extended RFG	Vector
p1120	Ramp-function generator ramp-up time	Vector	20	20 s	Vector
p1121	Ramp-function generator ramp-down time	Vector	30	30 s	Vector
p1135	OFF3 ramp-down time	Vector	10	10 s	Vector
p1200	Flying restart operating mode	Vector	0	Flying restart not active	Vector
p1208.0	BI: WEA infeed fault	Vector	r2139.3	Fault active	A_INF
p1208.1	BI: WEA infeed supply break	Vector	r0863.2	Drive link - infeed supply break	A_INF
p1240	Vdc controller configuration	Vector	0	Disable Vdc-max controller	Vector
p1254	Vdc controller automatic ON level detection	Vector	1	Automatic detection enabled	Vector

Sink			Source		
Parameter	Description	DO	Parameter	Description	DO
p1280	Vdc controller configuration (V/f)	Vector	0	Disable Vdc-max controller	Vector
p1300	Open-loop/closed-loop control operating mode	Vector	20	Encoderless speed control	Vector
p1911	Number of phases to be identified	Vector	3	3 phases	Vector
p2051[0]	CI: PROFIBUS PZD send word	Vector	r2089[0]	ZSW1	Vector
p2051[1]	CI: PROFIBUS PZD send word	Vector	r0063	n-act	Vector
p2051[2]	CI: PROFIBUS PZD send word	Vector	r0068	I-act	Vector
p2051[3]	CI: PROFIBUS PZD send word	Vector	r0080	M-act	Vector
p2051[4]	CI: PROFIBUS PZD send word	Vector	r0082	P-act	Vector
p2051[5]	CI: PROFIBUS PZD send word	Vector	r2131	FAULT	Vector
p2080[0]	BI: PROFIBUS send status word 1	Vector	r0899.0	Ready for switching on	Vector
p2080[1]	BI: PROFIBUS send status word 1	Vector	r0899.1	Ready for operation	Vector
p2080[2]	BI: PROFIBUS send status word 1	Vector	r0899.2	Operation	Vector
p2080[3]	BI: PROFIBUS send status word 1	Vector	r2139.3	Fault	Vector
p2080[4]	BI: PROFIBUS send status word 1	Vector	r0899.4	No OFF2	Vector
p2080[5]	BI: PROFIBUS send status word 1	Vector	r0899.5	No OFF3	Vector
p2080[6]	BI: PROFIBUS send status word 1	Vector	r0899.6	Switching on inhibited	Vector
p2080[7]	BI: PROFIBUS send status word 1	Vector	r2139.7	Alarm active	Vector
p2080[8]	BI: PROFIBUS send status word 1	Vector	r2197.7	No setpoint/actual value deviation	Vector
p2080[9]	BI: PROFIBUS send status word 1	Vector	r0899.9	Control request	Vector
p2080[10]	BI: PROFIBUS send status word 1	Vector	r2199.1	Comparison value reached	Vector
p2080[11]	BI: PROFIBUS send status word 1	Vector	r1407.7	M/I/P limiting not active	Vector
p2080[12]	BI: PROFIBUS send status word 1	Vector	0		Vector
p2080[13]	BI: PROFIBUS send status word 1	Vector	r2129.14	No alarm for motor overtemperature	Vector
p2080[14]	BI: PROFIBUS send status word 1	Vector	r2197.3	Clockwise	Vector
p2080[15]	BI: PROFIBUS send status word 1	Vector	r2129.15	No Therm. alarm Power unit overload	Vector
p2088	PROFIBUS Invert status word	Vector	B800h		Vector
p2128[14]	Select fault/alarm code for trigger	Vector	7910	A7910: Alarm, motor overtemperature	Vector
p2128[15]	Select fault/alarm code for trigger	Vector	5000	A5000: Therm. alarm Power unit overload	Vector
p2153	Time constant revolutions actual value filter	Vector	20	20 ms	Vector
p0840[0]	ON/OFF 1	A_INF	r0863.1	Energize line contactor	Vector
p2105	BI: 3. Acknowledge faults	A_INF	r1214.3	Automatic restart status – set acknowledgement command	Vector
p1207	BI: WEA link, following DO	A_INF	r1214.2	Automatic restart status – restart active	Vector
p4053[0]	TM31 analog inputs, smoothing time constant	TM31	0	0 ms	TM31
p4053[1]	TM31 analog inputs, smoothing time constant	TM31	0	0 ms	TM31

Sink			Source		
Parameter	Description	DO	Parameter	Description	DO
p4056[0]	Type of analog inputs	TM31	2	Current 0...20 mA	TM31
p4056[1]	Type of analog inputs	TM31	2	Current 0...20 mA	TM31
p4076[0]	Type of analog outputs	TM31	0	Current 0...20 mA	TM31
p4076[1]	Type of analog outputs	TM31	0	Current 0...20 mA	TM31
p4071[0]	Signal analog output 0	TM31	r0063	Actual speed smoothed	TM31
p4071[1]	Signal analog output 1	TM31	r0068	Absolute current actual value	TM31
p4100	Type of temperature sensor	TM31	0	(Factory setting)	TM31
p4102[0]	Alarm threshold, temperature sensing	TM31	251 °C	When this value is exceeded, alarm A35211 is triggered.	TM31
p4102[1]	Fault threshold for temperature sensing	TM31	251 °C	When this value is exceeded, fault F35207 is triggered.	TM31

Parameter macro p0700 = 5: PROFIdrive (70005)

This macro is used to set the PROFIdrive interface as the default command source.

Table A- 2 Parameter macro p0700 = 5: PROFIdrive

Sink			Source		
Parameter	Description	DO	Parameter	Description	DO
p0840[0]	ON/OFF1	Vector	r2090.0	PZD 1 bit 0	Vector
p0844[0]	No OFF2_1	Vector	r2090.1	PZD 1 bit 1	Vector
p0845[0]	No OFF2_2	Vector	r0722.3	CU DI3	CU
p0848[0]	No OFF3_1	Vector	r2090.2	PZD 1 bit 2	Vector
p0849[0]	No OFF3_2	Vector	r0722.2	CU DI2	CU
p0806	Inhibit LOCAL mode	Vector	0		Vector
p0810	Changeover CDS bit 0	Vector	0		Vector
p0852	Enable operation	Vector	r2090.3	PZD 1 bit 3	Vector
p0854	Control request	Vector	r2090.10	PZD 1 bit 10	Vector
p0922	PROFIdrive PZD telegram selection	Vector	999	Free telegram configuration	
p1020	FSW bit 0	Vector	0		Vector
p1021	FSW bit 1	Vector	0		Vector
p1035	MOP raise	Vector	r2090.13	PZD 1 bit 13	Vector
p1036	MOP lower	Vector	r2090.14	PZD 1 bit 14	Vector
p1113	Direction of rotation reversal	Vector	r2090.11	PZD 1 bit 11	Vector
p1140	Enable RFG	Vector	r2090.4	PZD 1 bit 4	Vector
p1141	Start RFG	Vector	r2090.5	PZD 1 bit 5	Vector
p1142	Enable nsetp	Vector	r2090.6	PZD 1 bit 6	Vector
p2103	Acknowledge fault 1	Vector	r2090.7	PZD 1 bit 7	Vector
p2104	Acknowledge fault 2	Vector	r4022.3	TM31 DI3	TM31
p2106	Ext. fault_1	Vector	r0722.1	CU DI1	CU
p2107	Ext. fault_2	Vector	1		Vector
p2112	Ext. alarm_1	Vector	r0722.0	CU DI0	CU

Sink			Source		
Parameter	Description	DO	Parameter	Description	DO
p2116	Ext. alarm_2	Vector	1		Vector
p0738	DI/DO8	CU	1	+24 V	CU
p0748.8	Invert DI/DO8	CU	0	Not inverted	
p0728.8	Set DI/DO8 input or output	CU	1	Output	
p0739	DI/DO9	CU	1	+24 V	CU
p0748.9	Invert DI/DO9	CU	0	Not inverted	
p0728.9	Set DI/DO9 input or output	CU	1	Output	
p0740	DI/DO10	CU	1	+24 V	CU
p0748.10	Invert DI/DO10	CU	0	Not inverted	
p0728.10	Set DI/DO10 input or output	CU	1	Output	
p0741	DI/DO11	CU	1	+24 V	CU
p0748.11	Invert DI/DO11	CU	0	Not inverted	
p0728.11	Set DI/DO11 input or output	CU	1	Output	
p0742	DI/DO12	CU	1	+24 V	CU
p0748.12	Invert DI/DO12	CU	0	Not inverted	
p0728.12	Set DI/DO12 input or output	CU	1	Output	
p0743	DI/DO13	CU	r0899.6	Switching on inhibited	Vector
p0748.13	Invert DI/DO13	CU	1	Inverted	
p0728.13	Set DI/DO13 input or output	CU	1	Output	
p0744	DI/DO14	CU	1	+24 V	CU
p0748.14	Invert DI/DO14	CU	0	Not inverted	
p0728.14	Set DI/DO14 input or output	CU	1	Output	
p0745	DI/DO15	CU	r2138.7	Ack. fault	Vector
p0748.15	Invert DI/DO15	CU	0	Not inverted	
p0728.15	Set DI/DO15 input or output	CU	1	Output	
p2103	Acknowledge fault 1	TM31	r2090.7	PZD 1 bit 7	Vector
p2104	Acknowledge fault 2	TM31	r4022.3	TM31 DI3	TM31
p4030	DO0	TM31	r0899.11	Pulses enabled	Vector
p4031	DO1	TM31	r2139.3	Fault	Vector
p4048.1	Invert DO1	TM31	1	Inverted	
p4038	DO8	TM31	r0899.0	Ready for switching on	Vector
p4028.8	Set DI/DO8 input or output	TM31	1	Output	
p4039	DO9	TM31	0		TM31
p4028.9	Set DI/DO9 input or output	TM31	0	Input	
p4040	DO10	TM31	0		TM31
p4028.10	Set DI/DO10 input or output	TM31	0	Input	
p4041	DO11	TM31	0		TM31
p4028.11	Set DI/DO11 input or output	TM31	0	Input	

Parameter macro p0700 = 6: Terminal block TM31 (70006)

This macro is used to set customer terminal block TM31 as the command source.

Table A- 3 Parameter macro p0700 = 6: Terminal block TM31

Sink			Source		
Parameter	Description	DO	Parameter	Description	DO
p0840[0]	ON/OFF1	Vector	r4022.0	TM31 DI0	TM31
p0844[0]	No OFF2_1	Vector	1		CU
p0845[0]	No OFF2_2	Vector	r0722.3	CU DI3	CU
p0848[0]	No OFF3_1	Vector	1		Vector
p0849[0]	No OFF3_2	Vector	r0722.2	CU DI2	CU
p0806	Inhibit LOCAL mode	Vector	0		Vector
p0810	Changeover CDS bit 0	Vector	0		Vector
p0852	Enable operation	Vector	r4022.4	TM31 DI4	TM31
p0854	Control request	Vector	1		Vector
p0922	PROFdrive PZD telegram selection	Vector	999	Free telegram configuration	
p1020	FSW bit 0	Vector	r4022.1	TM31 DI1	TM31
p1021	FSW bit 1	Vector	r4022.2	TM31 DI2	TM31
p1035	MOP raise	Vector	r4022.1	TM31 DI1	TM31
p1036	MOP lower	Vector	r4022.2	TM31 DI2	TM31
p1113	Direction of rotation reversal	Vector	0		TM31
p1140	Enable RFG	Vector	1		Vector
p1141	Start RFG	Vector	1		Vector
p1142	Enable nsetp	Vector	1		Vector
p2103	Acknowledge fault 1	Vector	0		Vector
p2104	Acknowledge fault 2	Vector	r4022.3	TM31 DI3	TM31
p2106	Ext. fault_1	Vector	r0722.1	CU DI1	CU
p2107	Ext. fault_2	Vector	1		Vector
p2112	Ext. alarm_1	Vector	r0722.0	CU DI0	CU
p2116	Ext. alarm_2	Vector	1		Vector
p0738	DI/DO8	CU	1	+24 V	CU
p0748.8	Invert DI/DO8	CU	0	Not inverted	
p0728.8	Set DI/DO8 input or output	CU	1	Output	
p0739	DI/DO9	CU	1	+24 V	CU
p0748.9	Invert DI/DO9	CU	0	Not inverted	
p0728.9	Set DI/DO9 input or output	CU	1	Output	
p0740	DI/DO10	CU	1	+24 V	CU
p0748.10	Invert DI/DO10	CU	0	Not inverted	
p0728.10	Set DI/DO10 input or output	CU	1	Output	
p0741	DI/DO11	CU	1	+24 V	CU
p0748.11	Invert DI/DO11	CU	0	Not inverted	
p0728.11	Set DI/DO11 input or output	CU	1	Output	

Sink			Source		
Parameter	Description	DO	Parameter	Description	DO
p0742	DI/DO12	CU	1	+24 V	CU
p0748.12	Invert DI/DO12	CU	0	Not inverted	
p0728.12	Set DI/DO12 input or output	CU	1	Output	
p0743	DI/DO13	CU	r0899.6	Switching on inhibited	Vector
p0748.13	Invert DI/DO13	CU	1	Inverted	
p0728.13	Set DI/DO13 input or output	CU	1	Output	
p0744	DI/DO14	CU	1	+24 V	CU
p0748.14	Invert DI/DO14	CU	0	Not inverted	
p0728.14	Set DI/DO14 input or output	CU	1	Output	
p0745	DI/DO15	CU	r2138.7	Ack. fault	Vector
p0748.15	Invert DI/DO15	CU	0	Not inverted	
p0728.15	Set DI/DO15 input or output	CU	1	Output	
p2103	Acknowledge fault 1	TM31	0		TM31
p2104	Acknowledge fault 2	TM31	r4022.3	TM31 DI3	TM31
p4030	DO0	TM31	r0899.11	Pulses enabled	Vector
p4031	DO1	TM31	r2139.3	Fault	Vector
p4048.1	Invert DO1	TM31	1	Inverted	
p4038	DO8	TM31	r0899.0	Ready for switching on	Vector
p4028.8	Set DI/DO8 input or output	TM31	1	Output	
p4039	DO9	TM31	0		TM31
p4028.9	Set DI/DO9 input or output	TM31	0	Input	
p4040	DO10	TM31	0		TM31
p4028.10	Set DI/DO10 input or output	TM31	0	Input	
p4041	DO11	TM31	0		TM31
p4028.11	Set DI/DO11 input or output	TM31	0	Input	

Parameter macro p0700 = 7: NAMUR (70007)

This macro is used to set the NAMUR terminal block as the default command source.

Table A- 4 Parameter macro p0700 = 7: NAMUR

Sink			Source		
Parameter	Description	DO	Parameter	Description	DO
p0840[0]	ON/OFF1	Vector	r4022.0	TM31 DI0	TM31
p0844[0]	No OFF2_1	Vector	r4022.4	TM31 DI4	TM31
p0845[0]	No OFF2_2	Vector	r0722.3	CU DI3	CU
p0848[0]	No OFF3_1	Vector	r4022.5	TM31 DI5	TM31
p0849[0]	No OFF3_2	Vector	1		Vector
p0806	Inhibit LOCAL mode	Vector	0		Vector
p0810	Changeover CDS bit 0	Vector	0		Vector
p0852	Enable operation	Vector	1		Vector
p0854	Control request	Vector	1		Vector
p0922	PROFIdrive PZD telegram selection	Vector	999	Free telegram configuration	
p1020	FSW bit 0	Vector	r4022.1	TM31 DI1	TM31
p1021	FSW bit 1	Vector	r4022.2	TM31 DI2	TM31
p1035	MOP raise	Vector	r4022.1	TM31 DI1	TM31
p1036	MOP lower	Vector	r4022.2	TM31 DI2	TM31
p1113	Direction of rotation reversal	Vector	r4022.6	TM31 DI6	TM31
p1140	Enable RFG	Vector	1		Vector
p1141	Start RFG	Vector	1		Vector
p1142	Enable nsetp	Vector	1		Vector
p2103	Acknowledge fault 1	Vector	0		Vector
p2104	Acknowledge fault 2	Vector	r4022.3	TM31 DI3	TM31
p2106	Ext. fault_1	Vector	r0722.1	CU DI1	CU
p2107	Ext. fault_2	Vector	1		Vector
p2112	Ext. alarm_1	Vector	r0722.0	CU DI0	CU
p2116	Ext. alarm_2	Vector	1		Vector
p0738	DI/DO8	CU	1	+24 V	CU
p0748.8	Invert DI/DO8	CU	0	Not inverted	
p0728.8	Set DI/DO8 input or output	CU	1	Output	
p0739	DI/DO9	CU	1	+24 V	CU
p0748.9	Invert DI/DO9	CU	0	Not inverted	
p0728.9	Set DI/DO9 input or output	CU	1	Output	
p0740	DI/DO10	CU	1	+24 V	CU
p0748.10	Invert DI/DO10	CU	0	Not inverted	
p0728.10	Set DI/DO10 input or output	CU	1	Output	
p0741	DI/DO11	CU	1	+24 V	CU
p0748.11	Invert DI/DO11	CU	0	Not inverted	
p0728.11	Set DI/DO11 input or output	CU	1	Output	
p0742	DI/DO12	CU	1	+24 V	CU

Sink			Source		
Parameter	Description	DO	Parameter	Description	DO
p0748.12	Invert DI/DO12	CU	0	Not inverted	
p0728.12	Set DI/DO12 input or output	CU	1	Output	
p0743	DI/DO13	CU	r0899.6	Switching on inhibited	Vector
p0748.13	Invert DI/DO13	CU	1	Inverted	
p0728.13	Set DI/DO13 input or output	CU	1	Output	
p0744	DI/DO14	CU	1	+24 V	CU
p0748.14	Invert DI/DO14	CU	0	Not inverted	
p0728.14	Set DI/DO14 input or output	CU	1	Output	
p0745	DI/DO15	CU	r2138.7	Ack. fault	Vector
p0748.15	Invert DI/DO15	CU	0	Not inverted	
p0728.15	Set DI/DO15 input or output	CU	1	Output	
p2103	Acknowledge fault 1	TM31	0		TM31
p2104	Acknowledge fault 2	TM31	r4022.3	TM31 DI3	TM31
p4030	DO0	TM31	r0899.11	Pulses enabled	Vector
p4031	DO1	TM31	r2139.3	Fault	Vector
p4048.1	Invert DO1	TM31	1	Inverted	
p4038	DO8	TM31	r0899.0	Ready for switching on	Vector
p4028.8	Set DI/DO8 input or output	TM31	1	Output	
p4039	DO9	TM31	0		TM31
p4028.9	Set DI/DO9 input or output	TM31	0	Input	
p4040	DO10	TM31	0		TM31
p4028.10	Set DI/DO10 input or output	TM31	0	Input	
p4041	DO11	TM31	0		TM31
p4028.11	Set DI/DO11 input or output	TM31	0	Input	

Parameter macro p0700 = 10: PROFIdrive NAMUR (70010)

This macro is used to set the PROFIdrive NAMUR interface as the default command source.

Table A- 5 Parameter macro p0700 = 10: PROFIdrive NAMUR

Sink			Source		
Parameter	Description	DO	Parameter	Description	DO
p0840[0]	ON/OFF1	Vector	0	Assignment with p0922 = 20	Vector
p0844[0]	No OFF2_1	Vector	1	Assignment with p0922 = 20	Vector
p0845[0]	No OFF2_2	Vector	r0722.3	CU DI3	CU
p0848[0]	No OFF3_1	Vector	0	Assignment with p0922 = 20	Vector
p0849[0]	No OFF3_2	Vector	1		Vector
p0806	Inhibit LOCAL mode	Vector	0		Vector
p0810	Changeover CDS bit 0	Vector	0		Vector
p0852	Enable operation	Vector	1	Assignment with p0922 = 20	Vector
p0854	Control request	Vector	1	Assignment with p0922 = 20	Vector
p0922	PROFIdrive PZD telegram selection	Vector	20	PROFIdrive NAMUR	
p1020	FSW bit 0	Vector	0		Vector
p1021	FSW bit 1	Vector	0		Vector
p1035	MOP raise	Vector	0		Vector
p1036	MOP lower	Vector	0		Vector
p1113	Direction of rotation reversal	Vector	0	Assignment with p0922 = 20	Vector
p1140	Enable RFG	Vector	1	Assignment with p0922 = 20	Vector
p1141	Start RFG	Vector	1	Assignment with p0922 = 20	Vector
p1142	Enable nsetp	Vector	1	Assignment with p0922 = 20	Vector
p2103	Acknowledge fault_1	Vector	0	Assignment with p0922 = 20	Vector
p2104	Acknowledge faults_2	Vector	0		Vector
p2106	Ext. fault_1	Vector	r0722.1	CU DI1	CU
p2107	Ext. fault_2	Vector	1		Vector
p2112	Ext. alarm_1	Vector	r0722.0	CU DI0	CU
p2116	Ext. alarm_2	Vector	1		Vector
p0738	DI/DO8	CU	1	+24 V	CU
p0748.8	Invert DI/DO8	CU	0	Not inverted	
p0728.8	Set DI/DO8 input or output	CU	1	Output	
p0739	DI/DO9	CU	1	+24 V	CU
p0748.9	Invert DI/DO9	CU	0	Not inverted	
p0728.9	Set DI/DO9 input or output	CU	1	Output	
p0740	DI/DO10	CU	1	+24 V	CU
p0748.10	Invert DI/DO10	CU	0	Not inverted	
p0728.10	Set DI/DO10 input or output	CU	1	Output	
p0741	DI/DO11	CU	1	+24 V	CU
p0748.11	Invert DI/DO11	CU	0	Not inverted	
p0728.11	Set DI/DO11 input or output	CU	1	Output	

Sink			Source		
Parameter	Description	DO	Parameter	Description	DO
p0742	DI/DO12	CU	1	+24 V	CU
p0748.12	Invert DI/DO12	CU	0	Not inverted	
p0728.12	Set DI/DO12 input or output	CU	1	Output	
p0743	DI/DO13	CU	r0899.6	Switching on inhibited	Vector
p0748.13	Invert DI/DO13	CU	1	Inverted	
p0728.13	Set DI/DO13 input or output	CU	1	Output	
p0744	DI/DO14	CU	1	+24 V	CU
p0748.14	Invert DI/DO14	CU	0	Not inverted	
p0728.14	Set DI/DO14 input or output	CU	1	Output	
p0745	DI/DO15	CU	r2138.7	Ack. fault	Vector
p0748.15	Invert DI/DO15	CU	0	Not inverted	
p0728.15	Set DI/DO15 input or output	CU	1	Output	
p2103	Acknowledge fault 1	TM31	0		TM31
p2104	Acknowledge fault 2	TM31	0		TM31
p4030	DO0	TM31	0		Vector
p4031	DO1	TM31	0		Vector
p4038	DO8	TM31	0		Vector
p4028.8	Set DI/DO8 input or output	TM31	0	Input	
p4039	DO9	TM31	0		TM31
p4028.9	Set DI/DO9 input or output	TM31	0	Input	
p4040	DO10	TM31	0		TM31
p4028.10	Set DI/DO10 input or output	TM31	0	Input	
p4041	DO11	TM31	0		TM31
p4028.11	Set DI/DO11 input or output	TM31	0	Input	

Parameter macro p1000 = 1: PROFIdrive (100001)

This macro is used to set the default setpoint source via PROFIdrive.

Table A- 6 Parameter macro p1000 = 1: PROFIdrive

Sink			Source		
Parameters	Description	DO	Parameters	Description	DO
p1070	Main setpoint	Vector	r2050[1]	PROFIdrive PZD2	Vector
p1071	Main setpoint scaling	Vector	1	100 %	Vector
p1075	Supplementary setpoint	Vector	0		Vector
p1076	Supplementary setpoint scaling	Vector	1	100 %	Vector

Parameter macro p1000 = 2: Terminal TM31 (100002)

This macro is used to set analog input 0 on customer terminal block TM31 as the setpoint source.

Table A- 7 Parameter macro p1000 = 2: TM31 terminals

Sink			Source		
Parameter	Description	DO	Parameter	Description	DO
p1070	Main setpoint	Vector	r4055	AI0 TM31	TM31
p1071	Main setpoint scaling	Vector	1	100 %	Vector
p1075	Supplementary setpoint	Vector	0		Vector
p1076	Supplementary setpoint scaling	Vector	1	100 %	Vector

Parameter macro p1000 = 3: Motorized potentiometer (100003)

This macro is used to set the motorized potentiometer as the setpoint source.

Table A- 8 Parameter macro p1000 = 3: Motorized potentiometer

Sink			Source		
Parameters	Description	DO	Parameters	Description	DO
p1070	Main setpoint	Vector	r1050	Motorized potentiometer	Vector
p1071	Main setpoint scaling	Vector	1	100 %	Vector
p1075	Supplementary setpoint	Vector	0		Vector
p1076	Supplementary setpoint scaling	Vector	1	100 %	Vector

Parameter macro p1000 = 4: Fixed setpoint (100004)

This macro is used to set the fixed setpoint as the setpoint source.

Table A-9 Parameter macro p1000 = 4: Fixed setpoint

Sink			Source		
Parameters	Description	DO	Parameters	Description	DO
p1070	Main setpoint	Vector	r1024	Active fixed setpoint	Vector
p1071	Main setpoint scaling	Vector	1	100 %	Vector
p1075	Supplementary setpoint	Vector	0		Vector
p1076	Supplementary setpoint scaling	Vector	1	100 %	Vector

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